Satellite Analysis

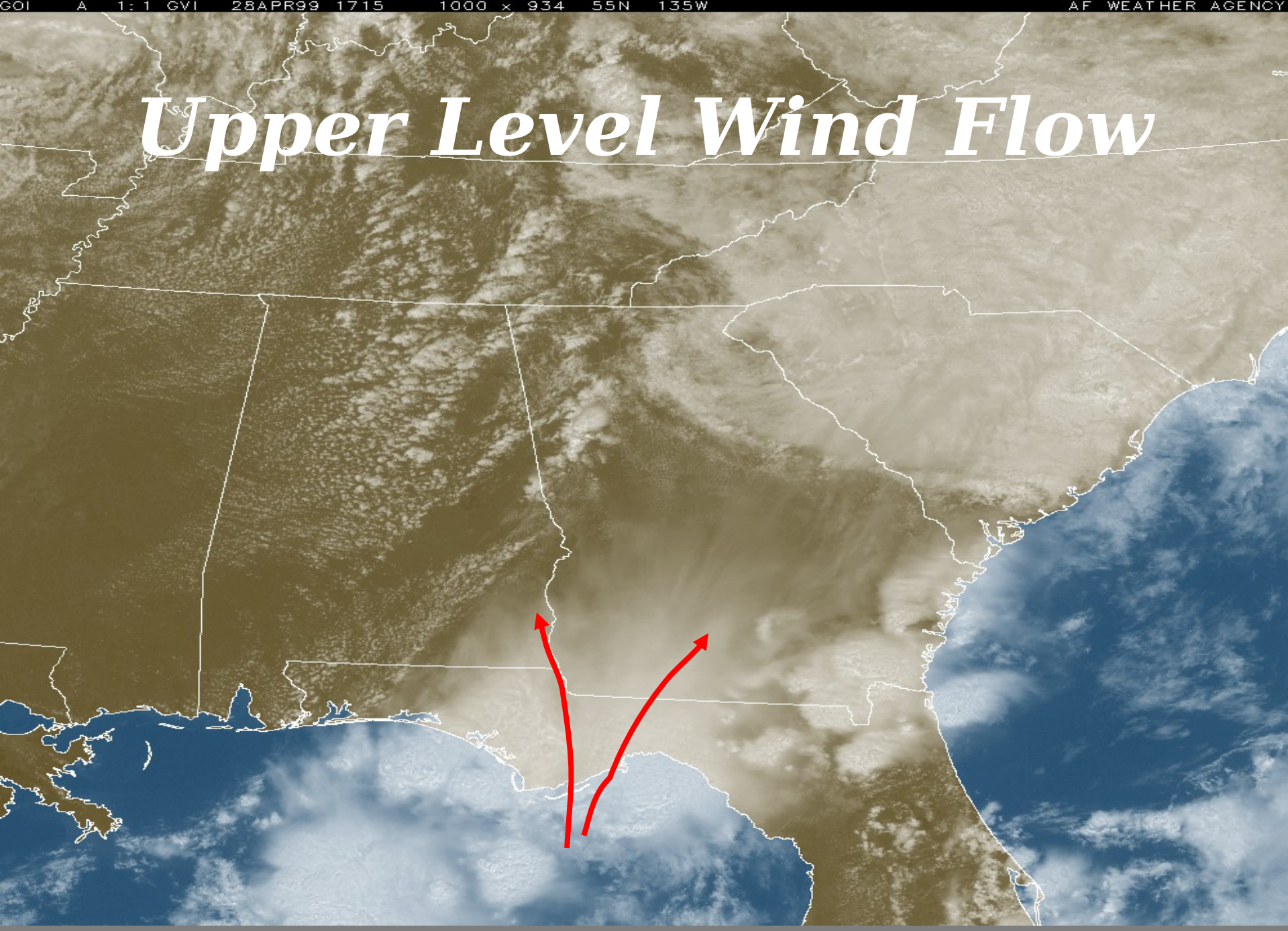
2d. Determine wind flow on satellite imagery.

Windflow

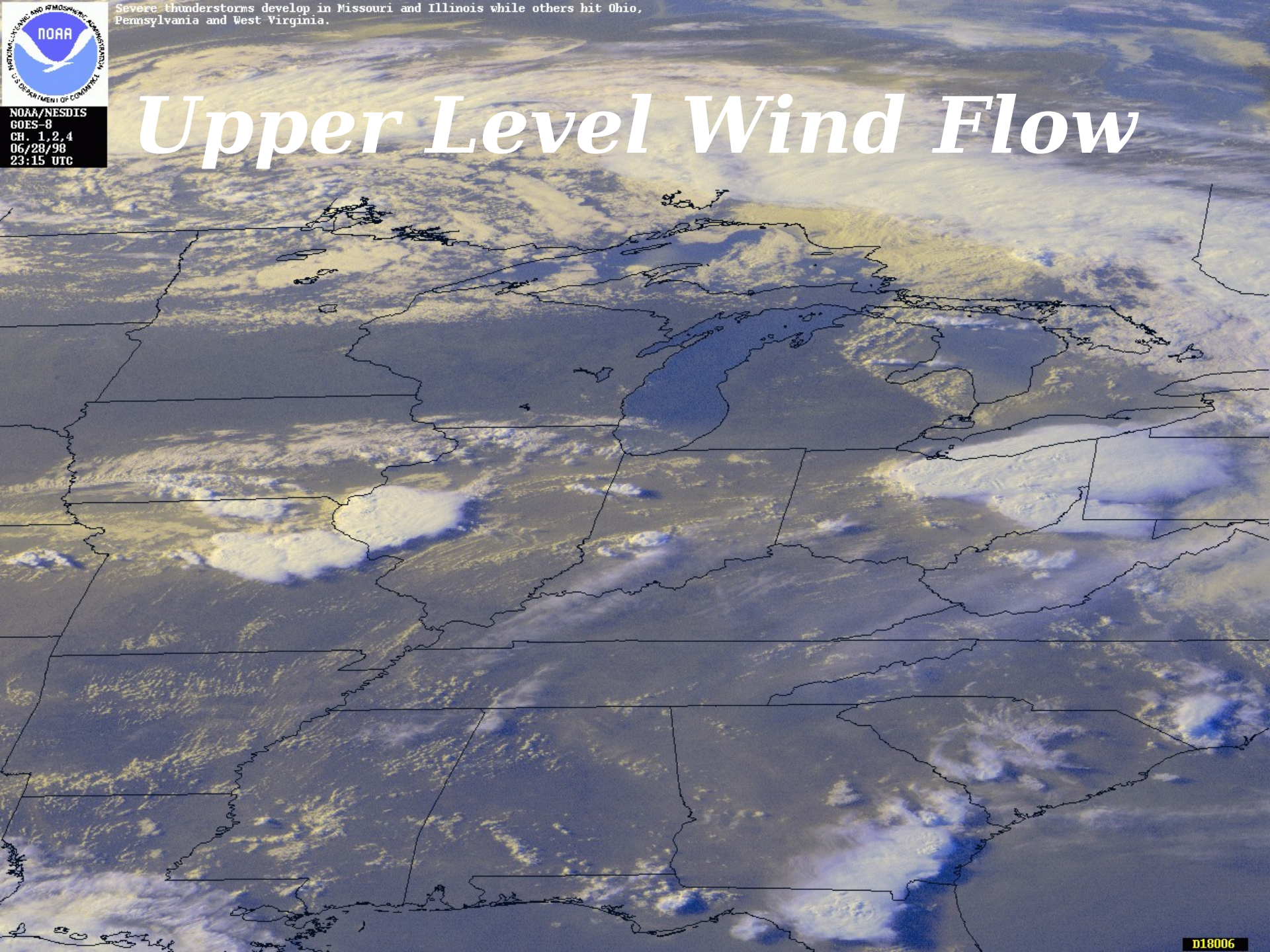
- Upper-level flow
  - Analyze the pattern/motion of high clouds
    - Upstream edge of cloudiness is well defined; Downstream more diffuse on visual imagery
    - Sharp temperature gradient found on up streamside on IR imagery
    - For slow moving parent weather system, clouds are parallel to upper-wind flow
    - For fast moving parent weather system, the upper flow is the vector sum of cloud orientation plus system movement

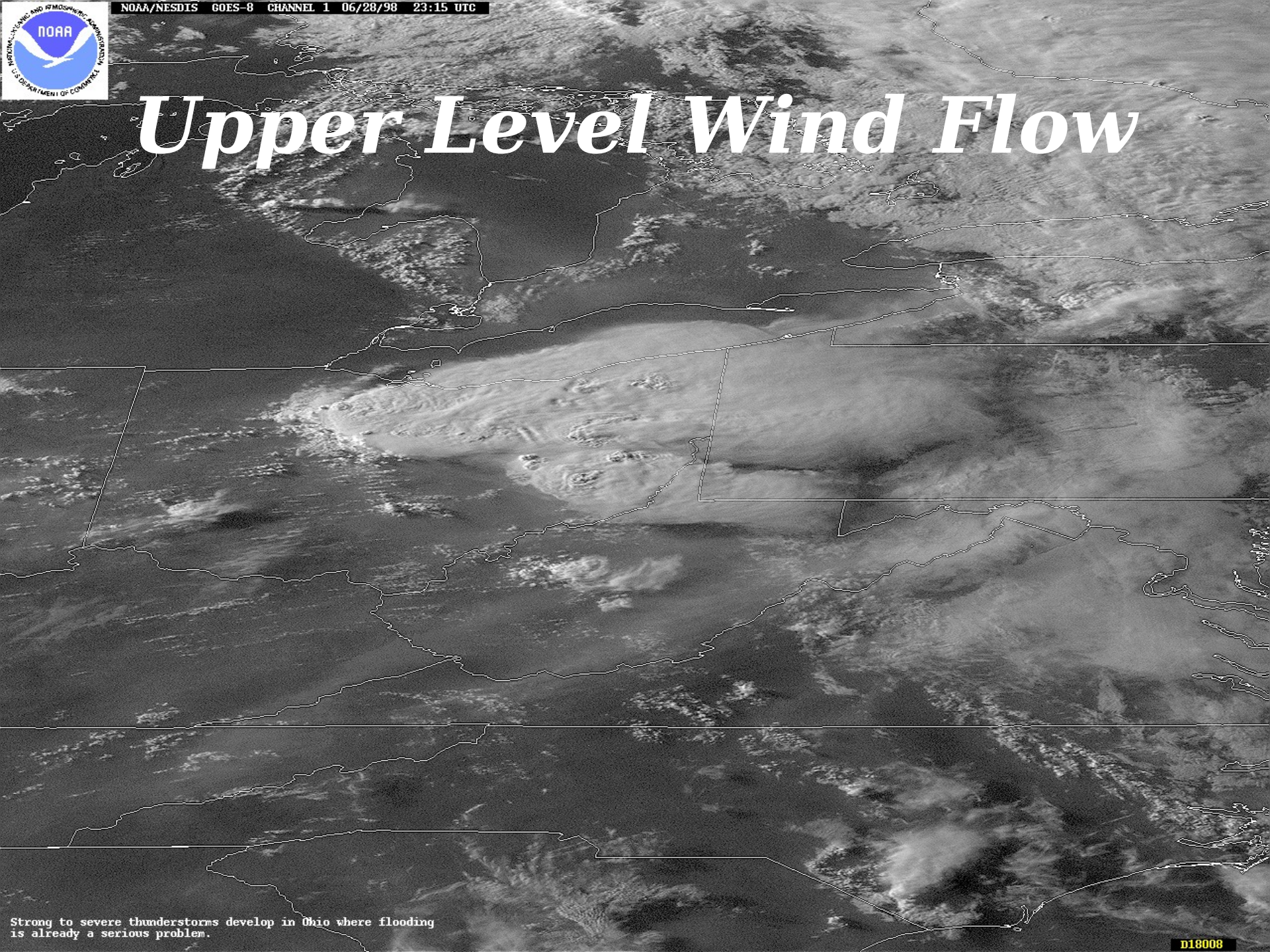
GOI A 1:1 GVI 28APR99 1715 1000 x 934 55N 135W AF WEATHER AGENCY

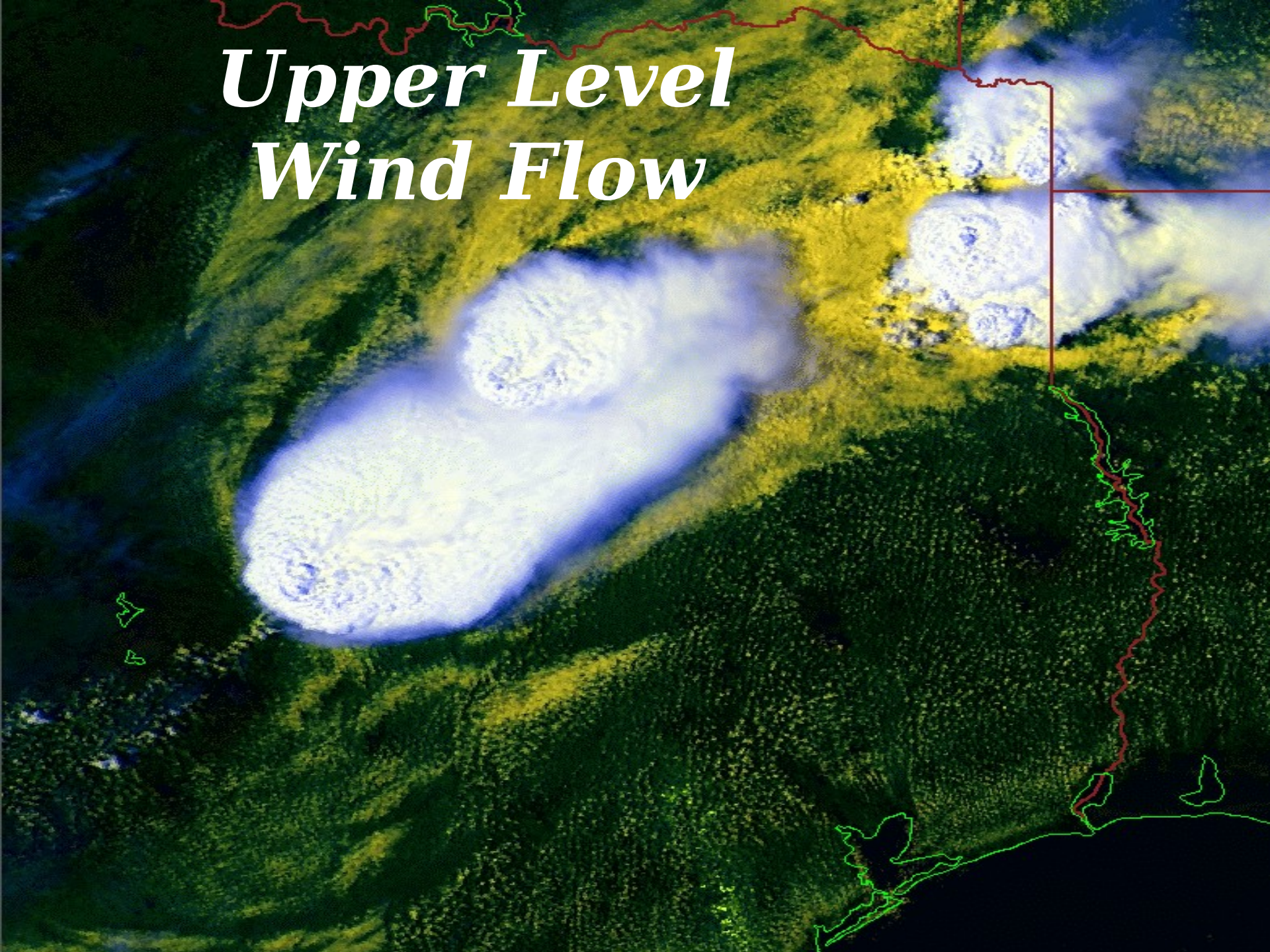
Upper Level Wind Flow



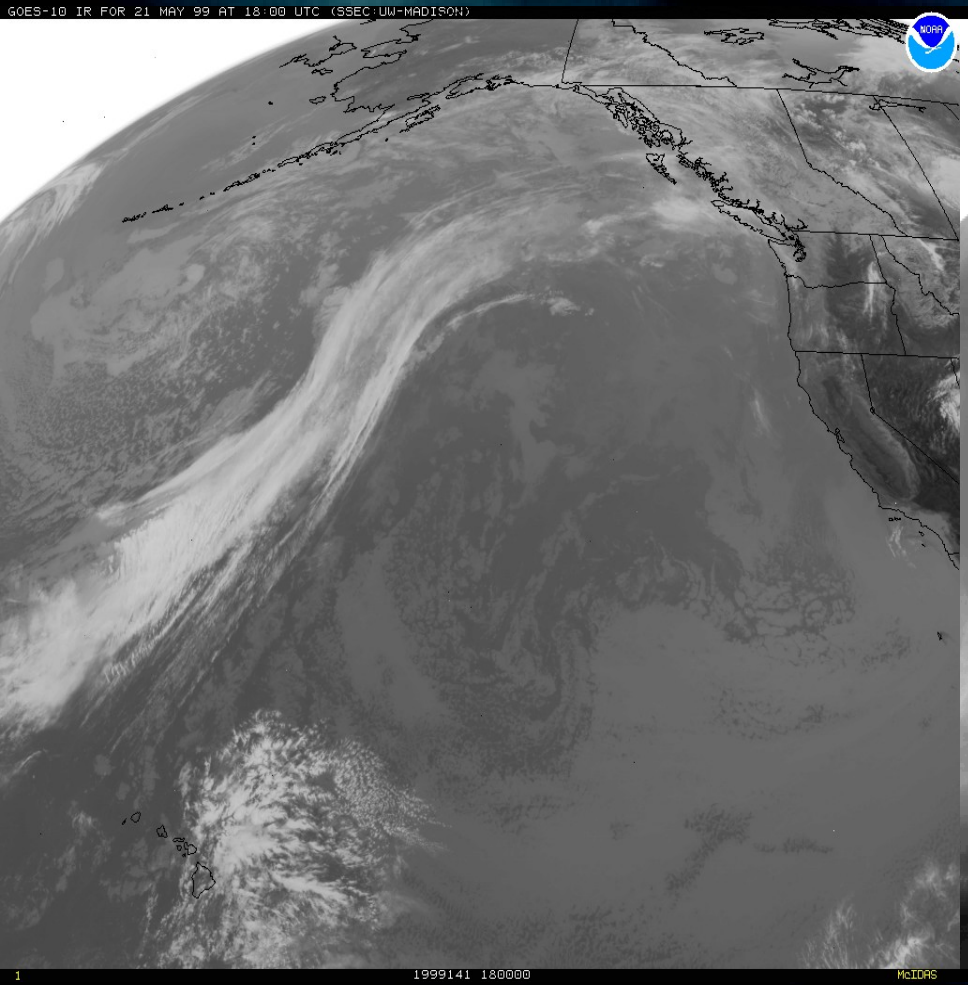
Determine windflow on satellite

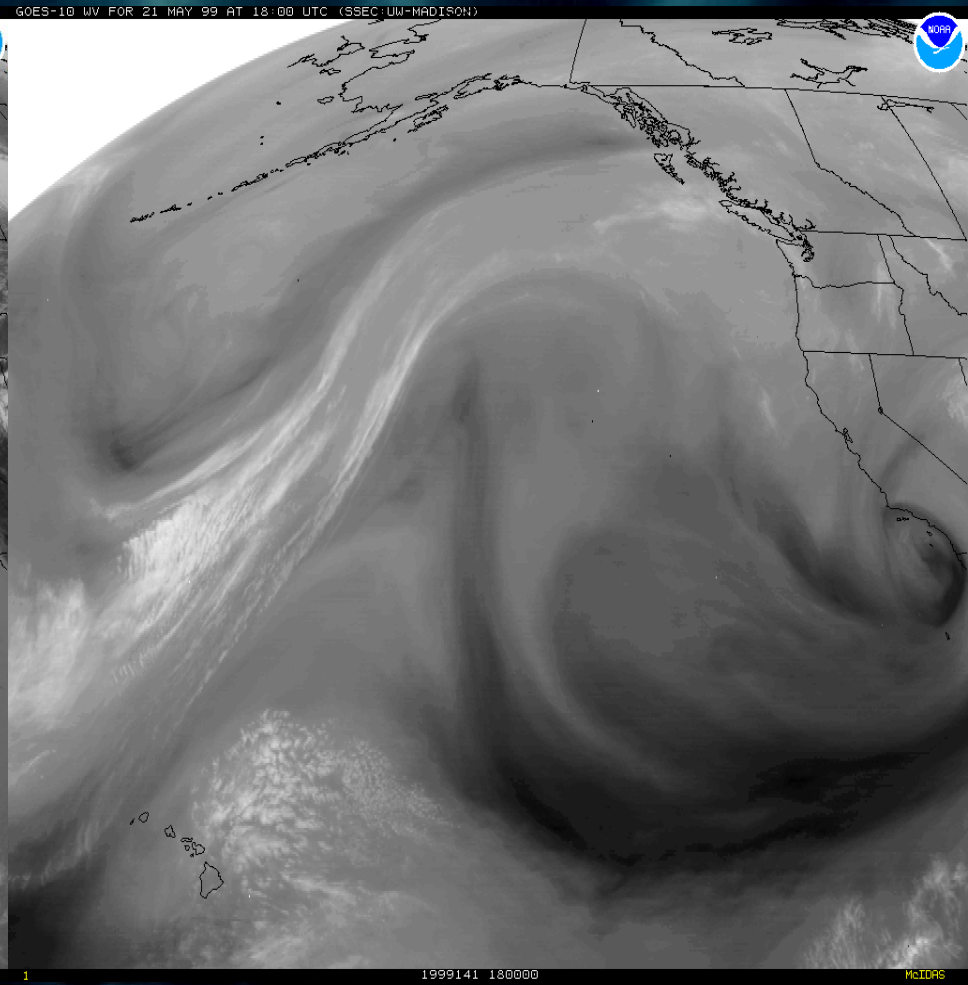

Severe thunderstorms develop in Missouri and Illinois while others hit Ohio, Pennsylvania and West Virginia.
NOAA/NESDIS
GOES-8
CH. 1,2,4
06/28/98
23:15 UTC
Upper Level Wind Flow
D18006

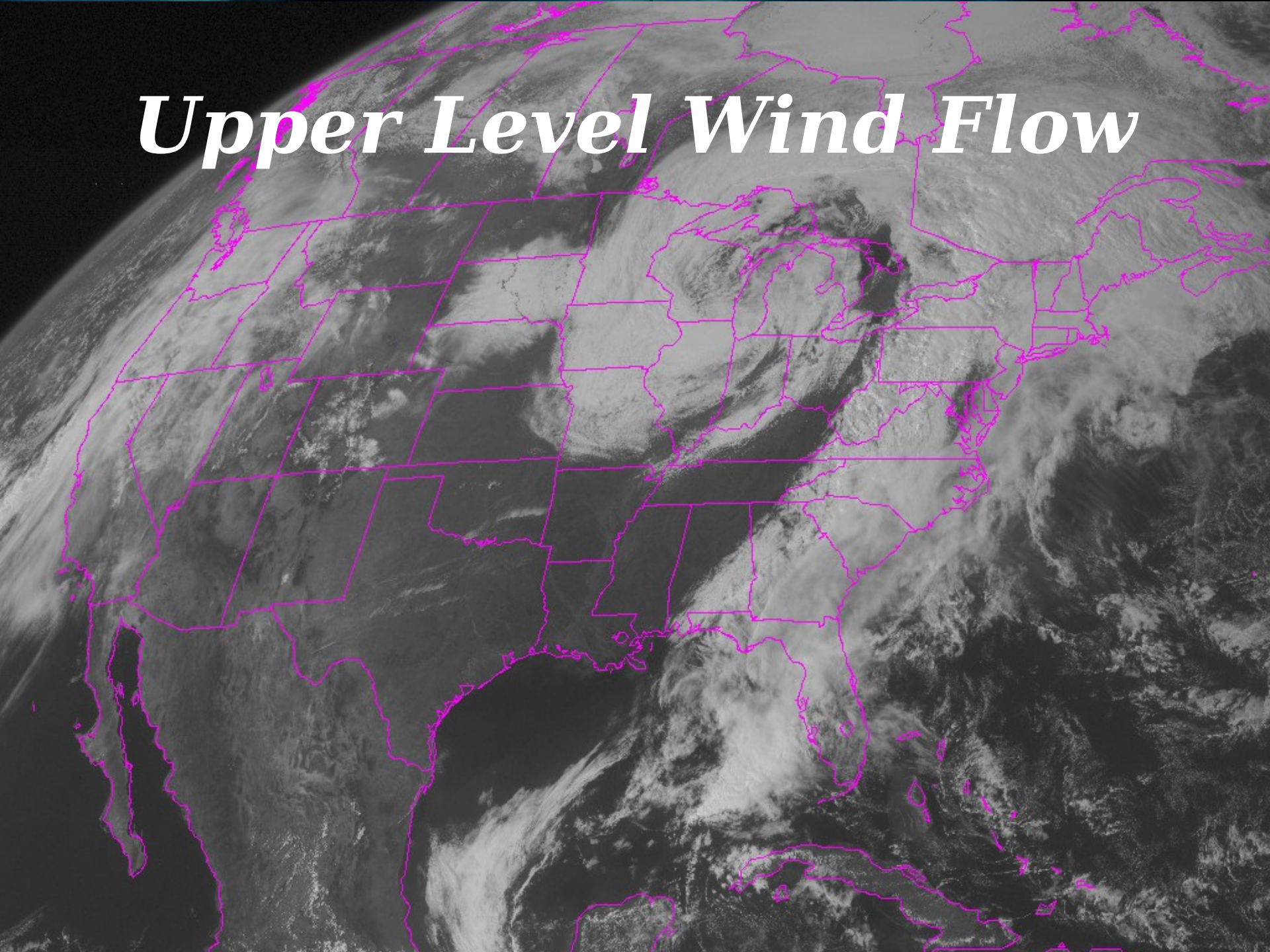

NOAA/NESDIS GOES-8 CHANNEL 1 06/28/98 23:15 UTC
Upper Level Wind Flow
Strong to severe thunderstorms develop in Ohio where flooding is already a serious problem.
D18008

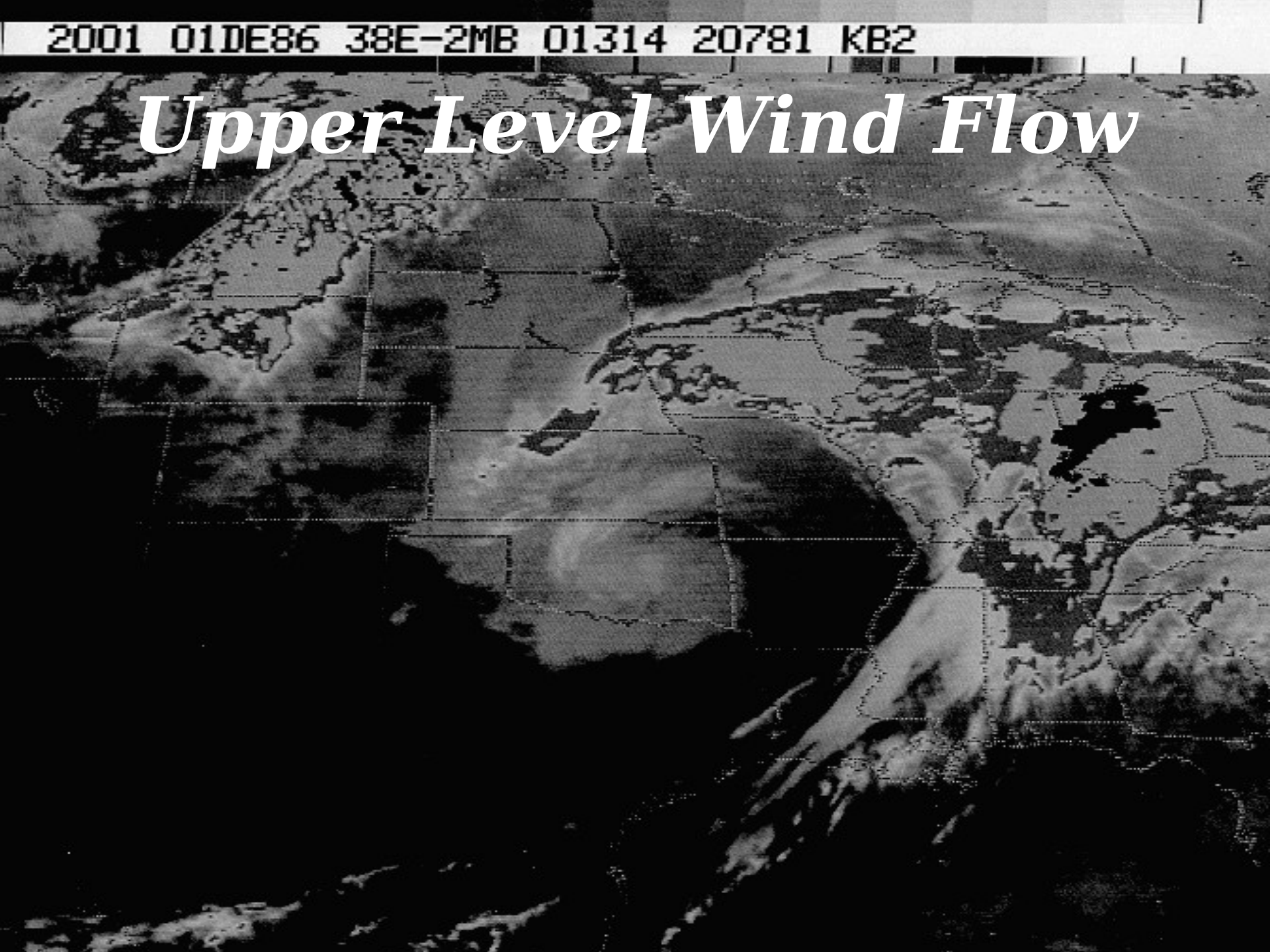

Upper Level
Wind Flow

Upper Level Wind Flow





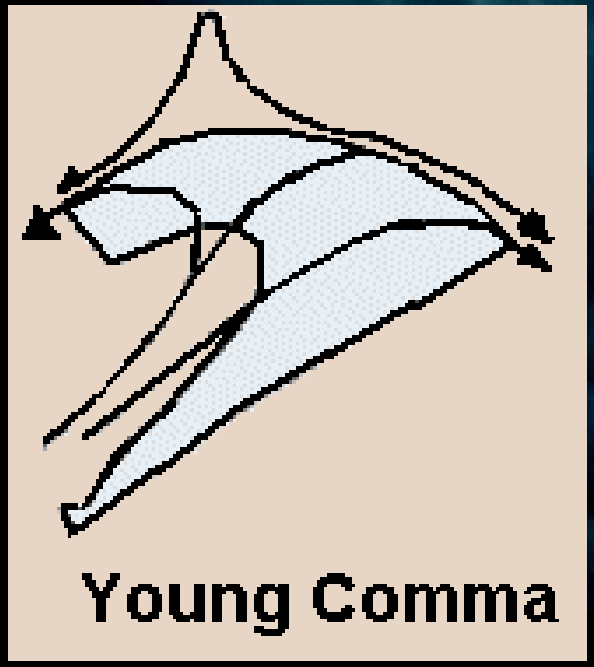

Upper Level Wind Flow

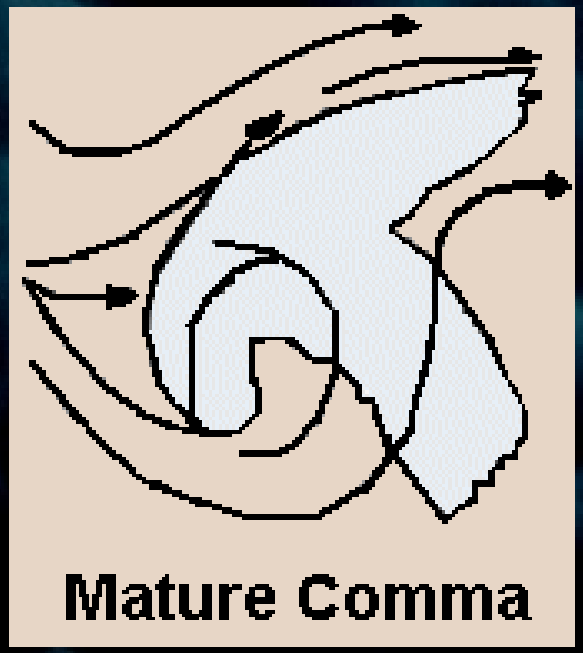

2001 01DE86 38E-2MB 01314 20781 KB2
Upper Level Wind Flow

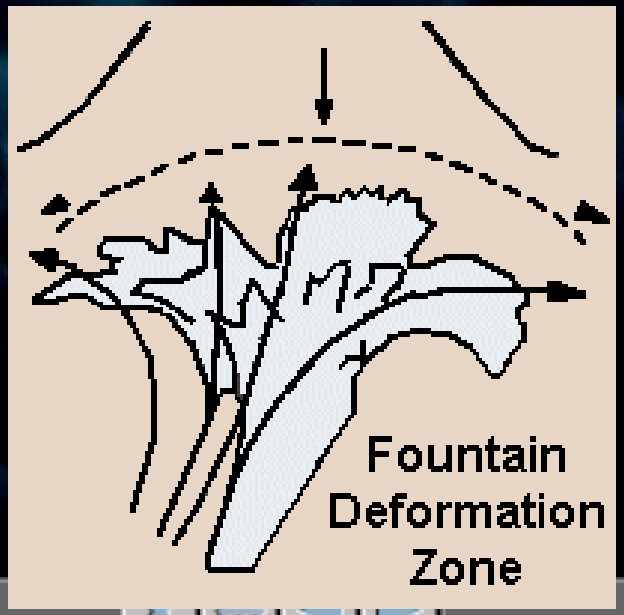
Wind Flow

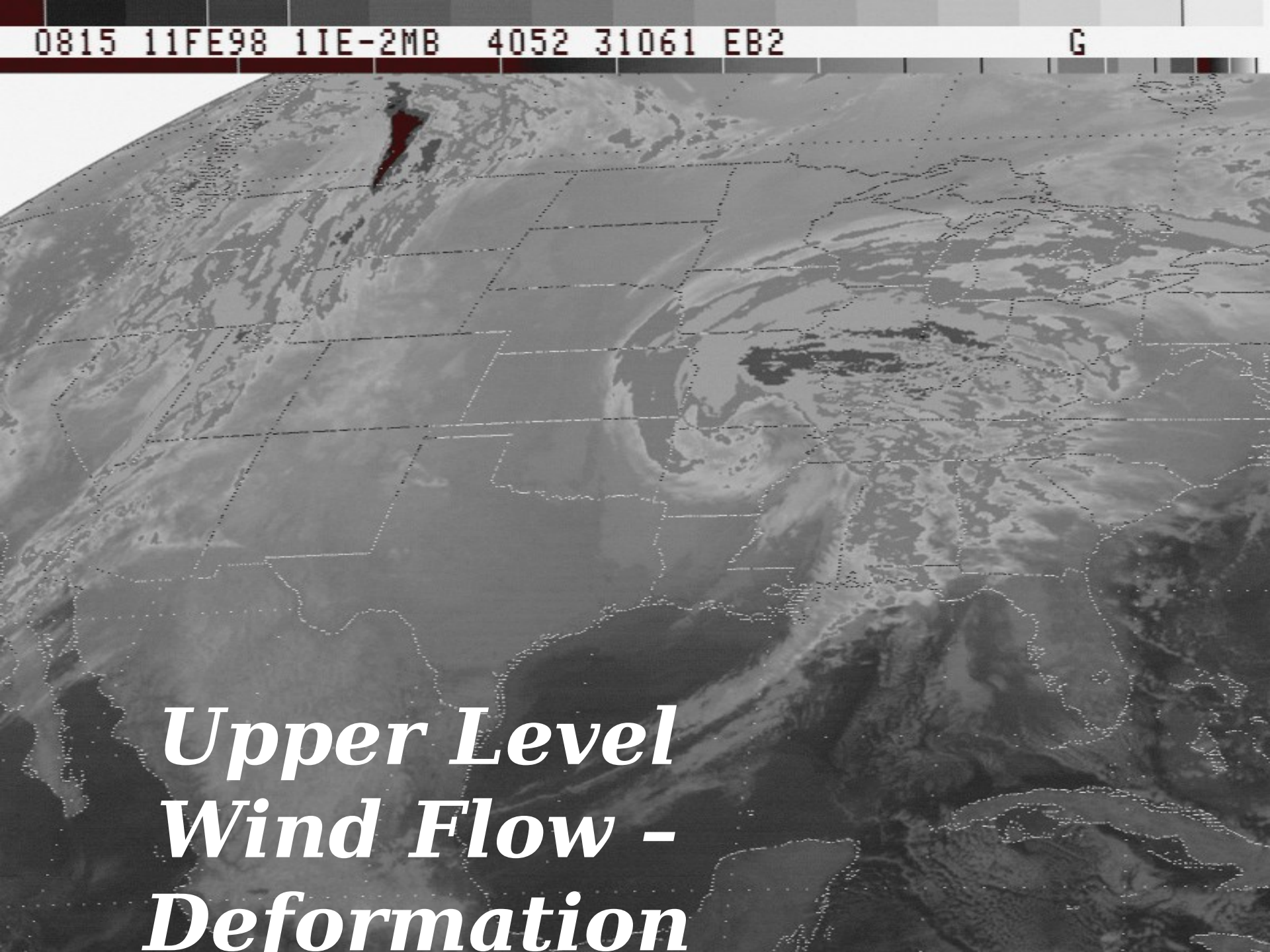
- Upper-level deformation zones
  - Formation occurs when the upper low begins to close off
  - There is a sharp gray shade contrast (between dry and moist) on WV imagery

Upper-level Deformation Zone

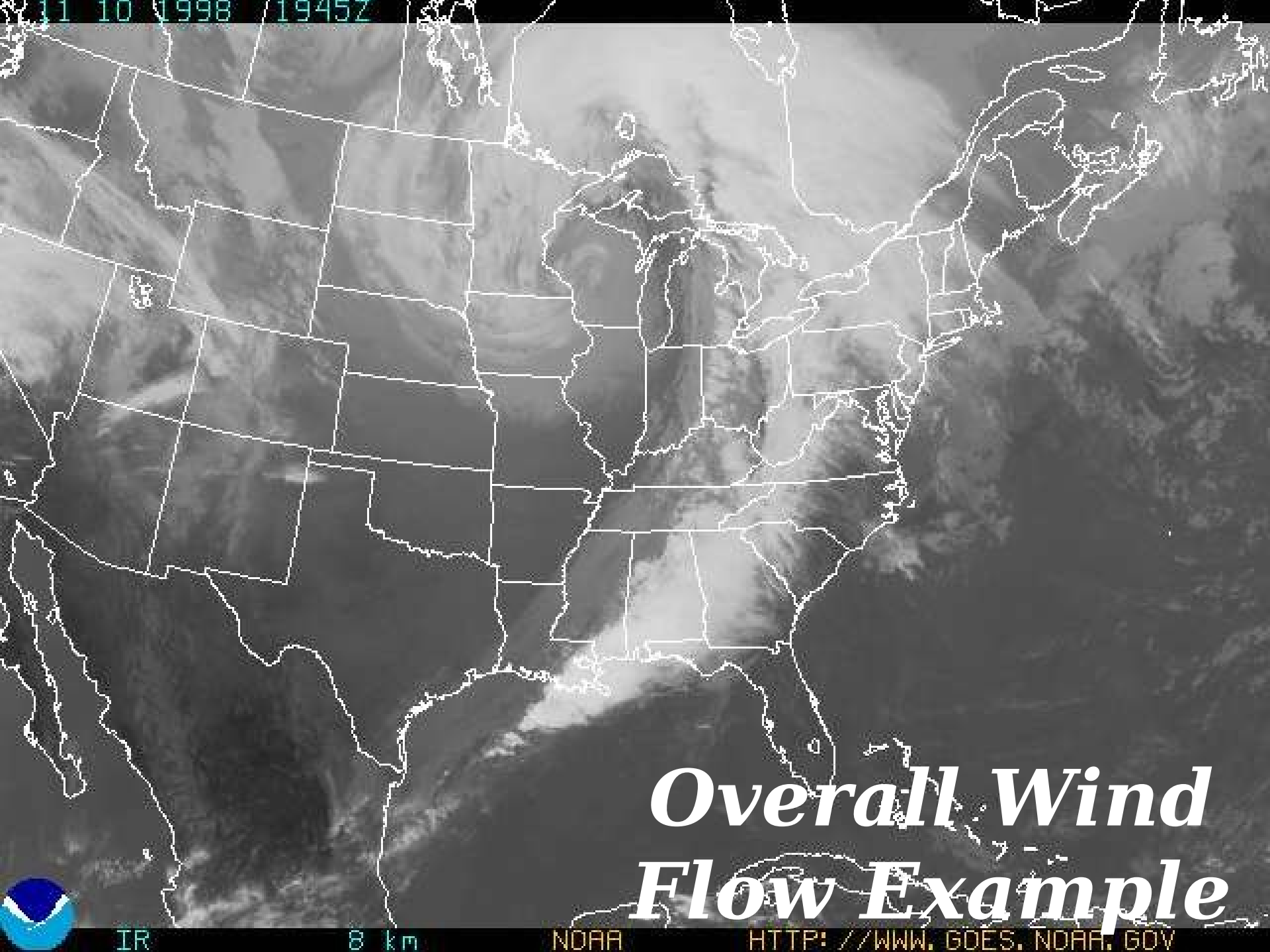






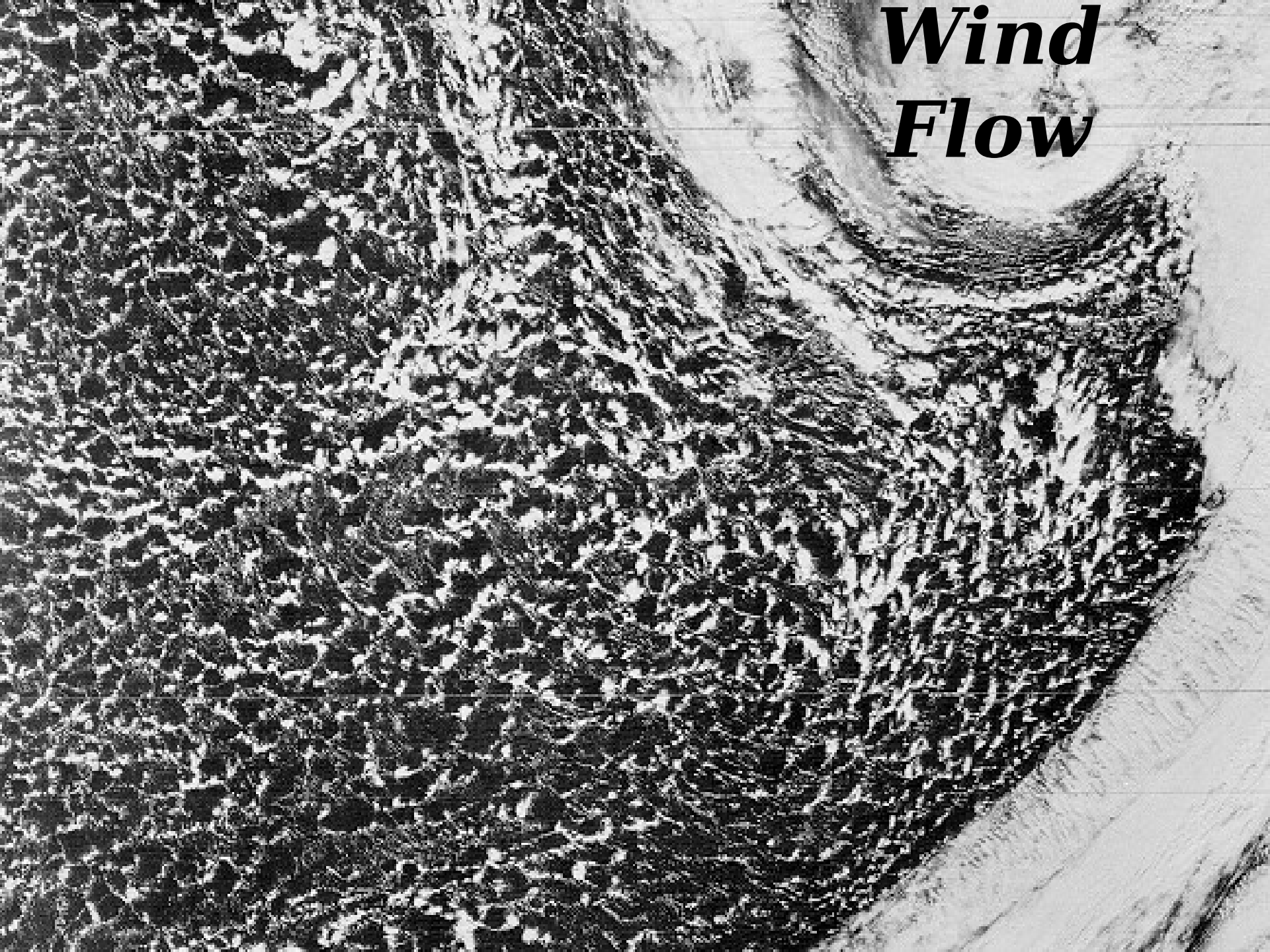


Upper Level Wind Flow – Deformation


11 10 1998 /1945Z
Overall Wind Flow Example
IR
8 km
NOAA
HTTP://WWW.GOES.NOAA.GOV

Wind Flow

- Low-level flow
  - General indicators
    - Use an atlas for terrain features
    - Use cloud and non-cloud features
      - Open-cell cumulus
        - » Look for the formation of open-cell cumulus found in straight line or cyclonic flow
        - » The cloud shape is dependent on wind speed


Wind
Flow

Wind Flow

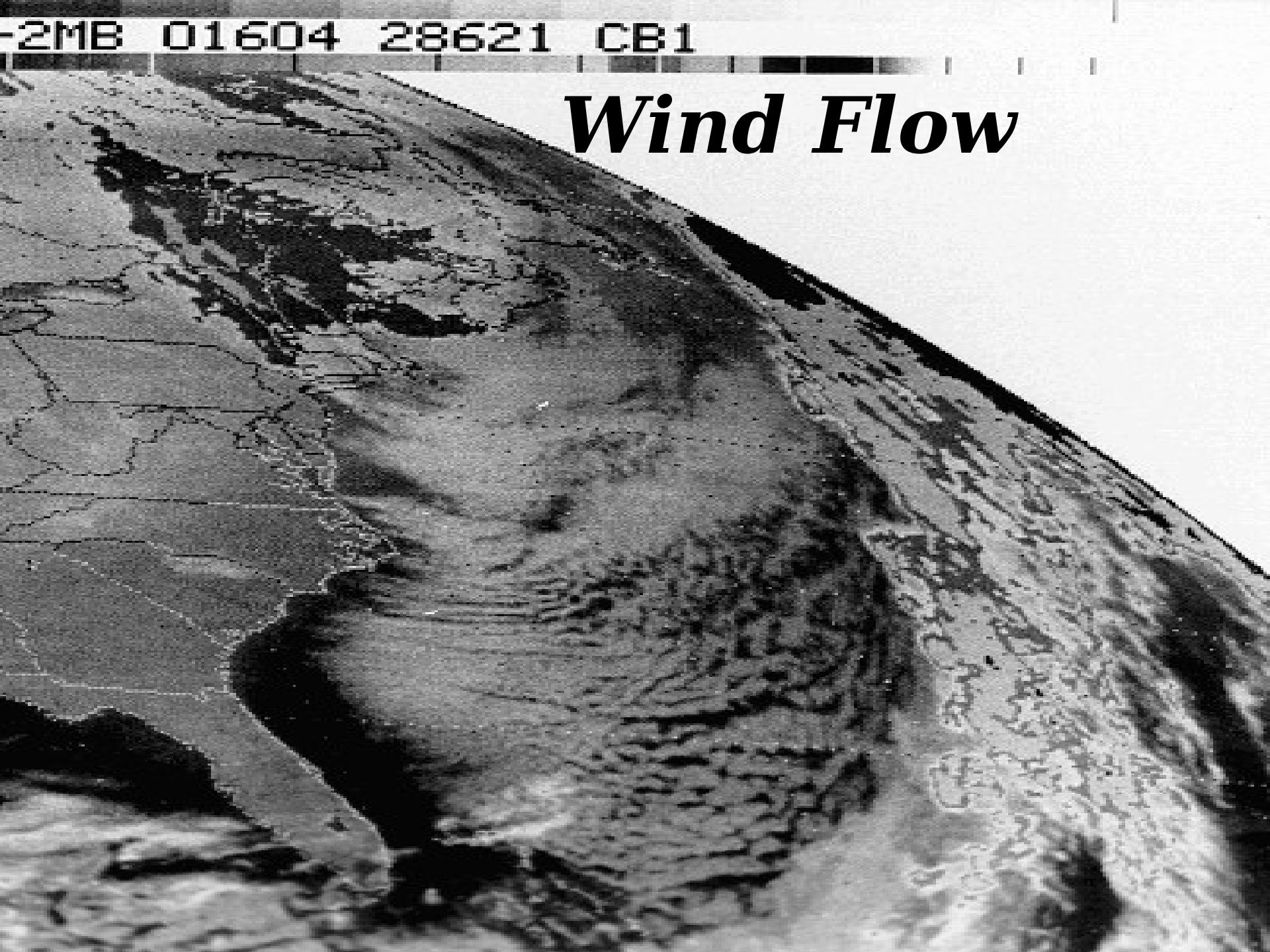
- Closed-cell stratocumulus are found in anticyclonic flow with wind speeds less

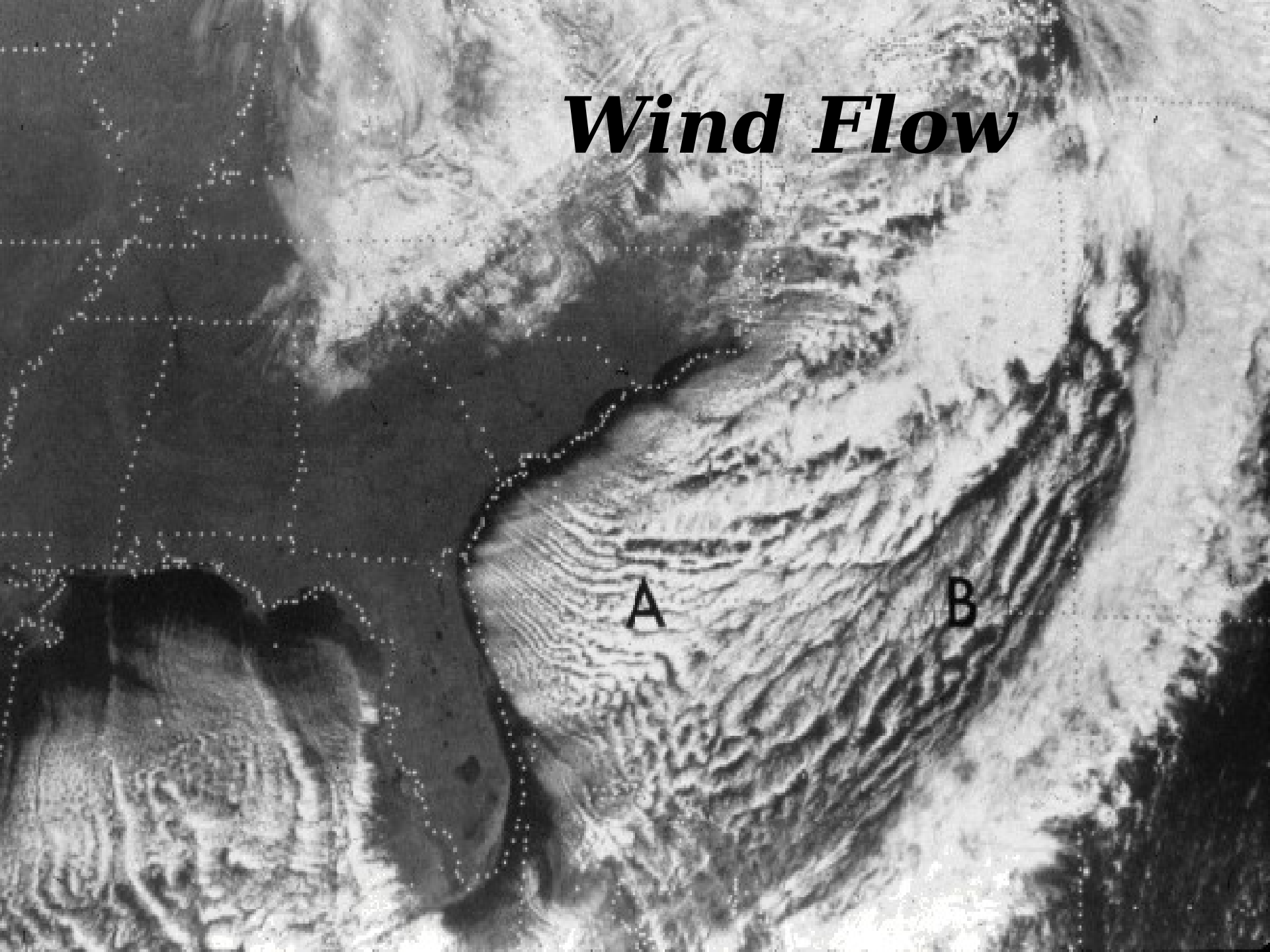
Wind Flow

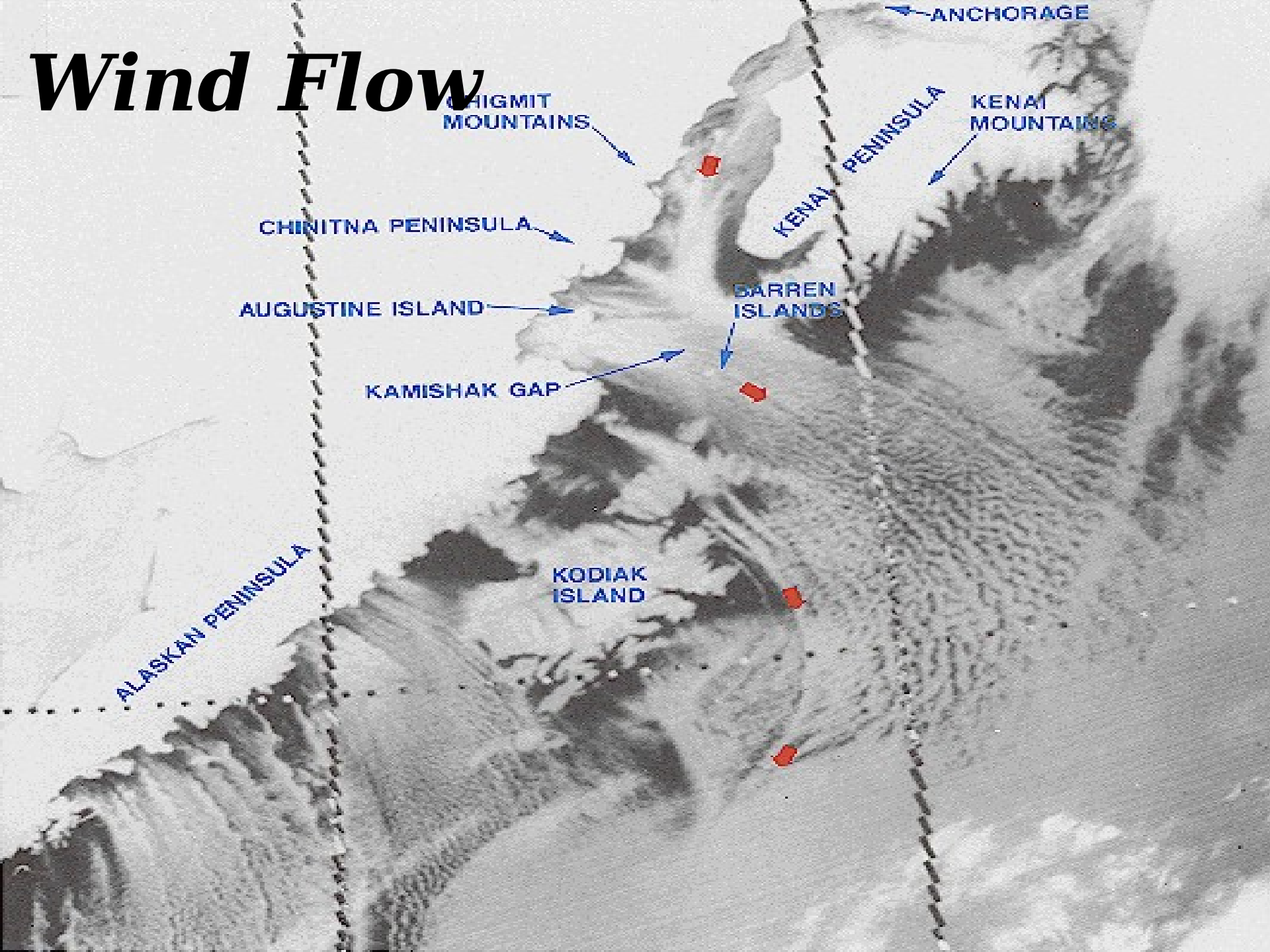
- Stratocumulus lines
  - It is located off of eastern and southern coasts and over large lakes
  - The wind flow is parallel to cloud lines in cyclonic, anticyclonic, or straight-line flow
  - Wind speed

    A. The smaller the element, the greater the speed

    B. There is a clear separation of lines if the winds are greater than 20 knots

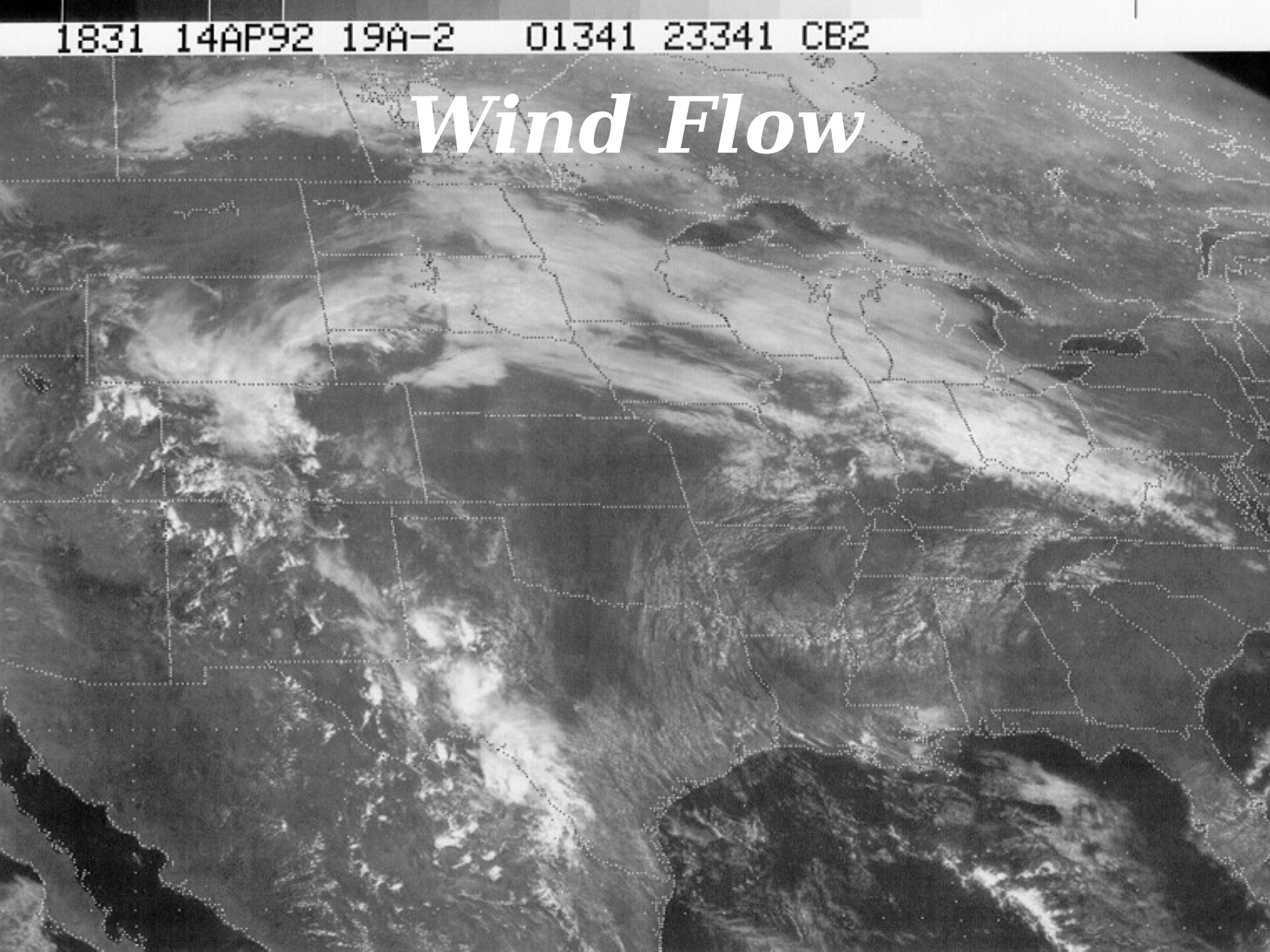

-2MB 01604 28621 CB1
Wind Flow

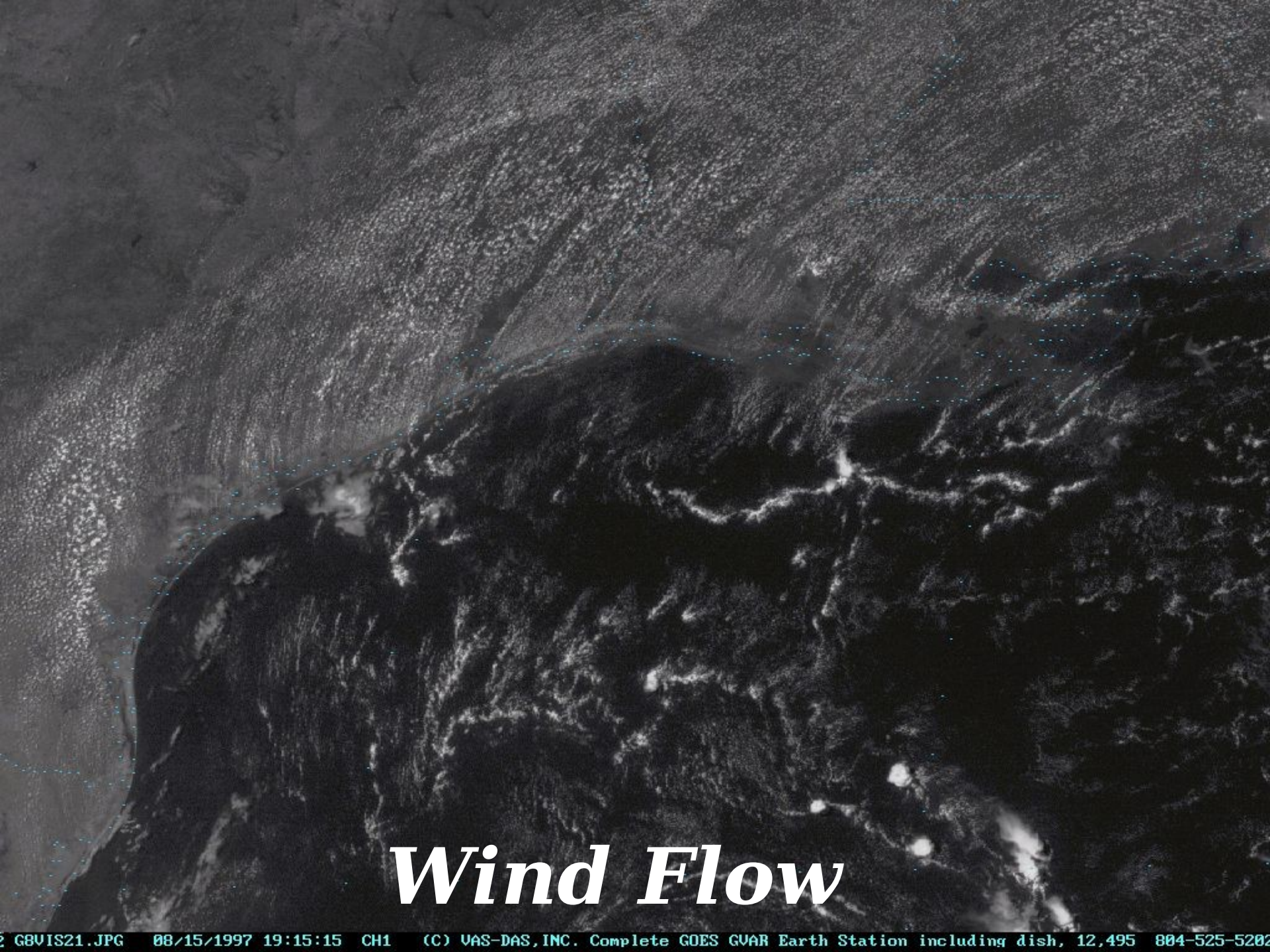

Wind Flow
A
B

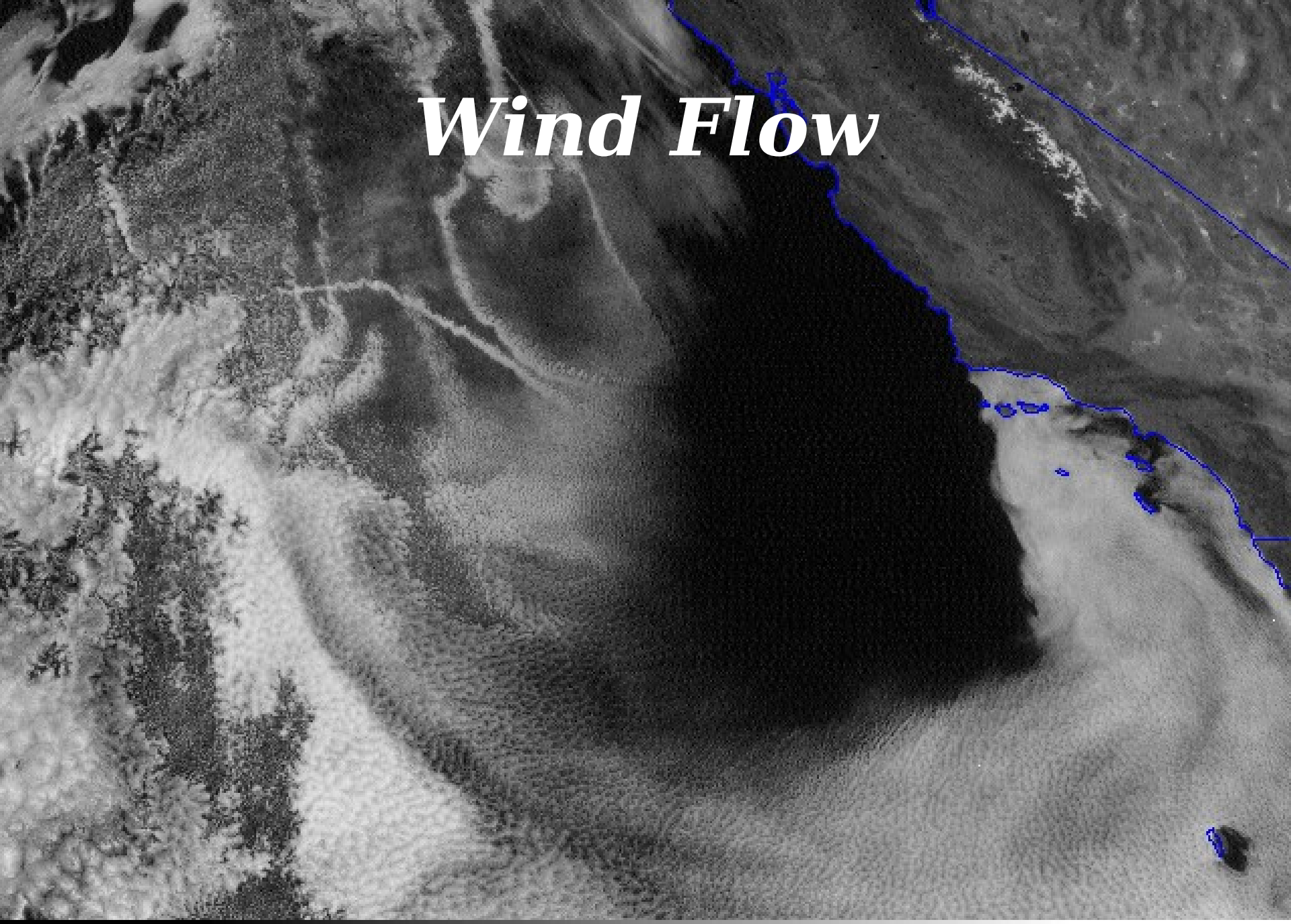

Wind Flow
ANCHORAGE
CHIGMIT MOUNTAINS
KENAI PENINSULA
KENAI MOUNTAINS
CHINITNA PENINSULA
AUGUSTINE ISLAND
BARREN ISLANDS
KAMISHAK GAP
KODIAK ISLAND
ALASKAN PENINSULA

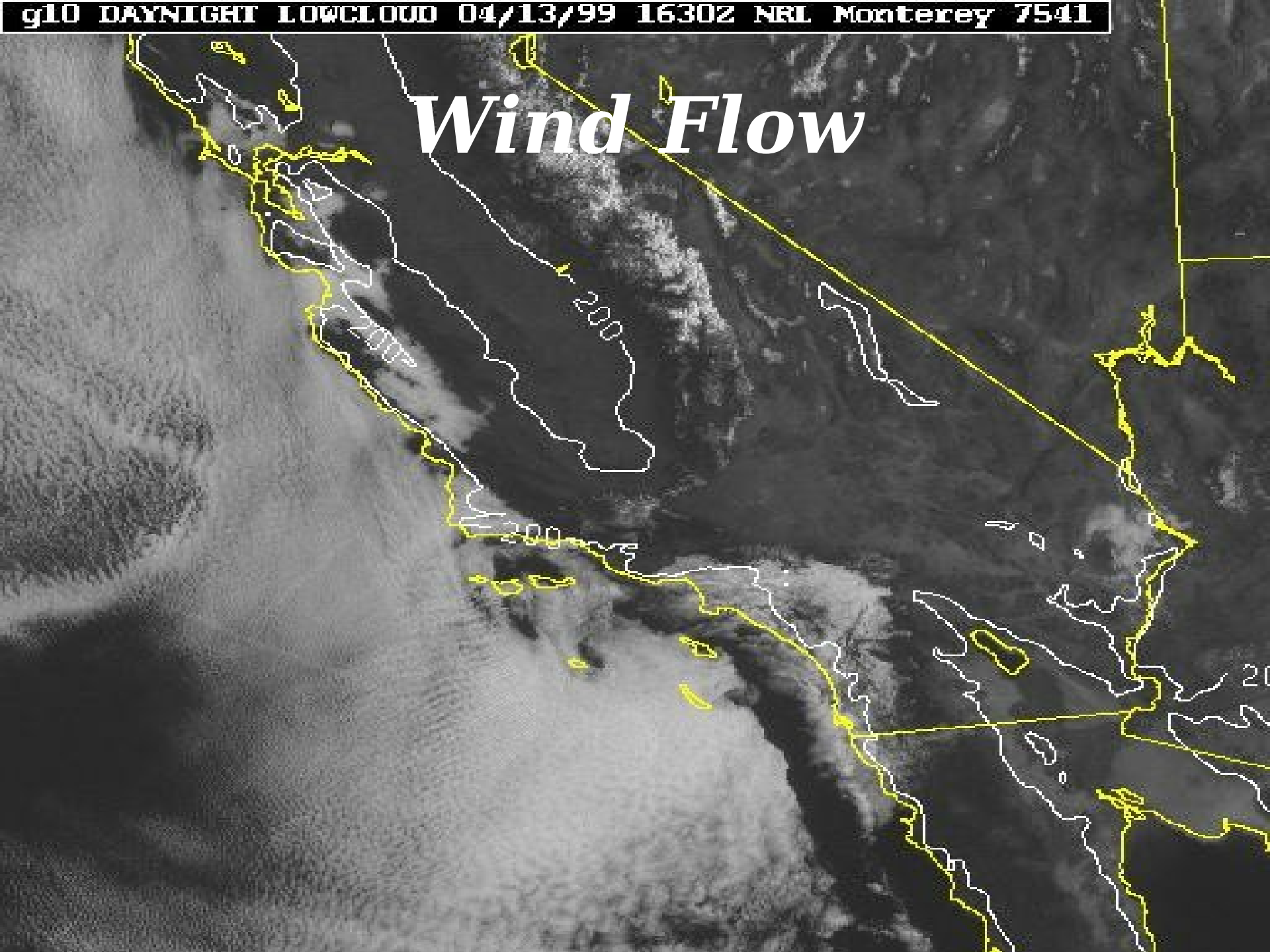
Wind Flow

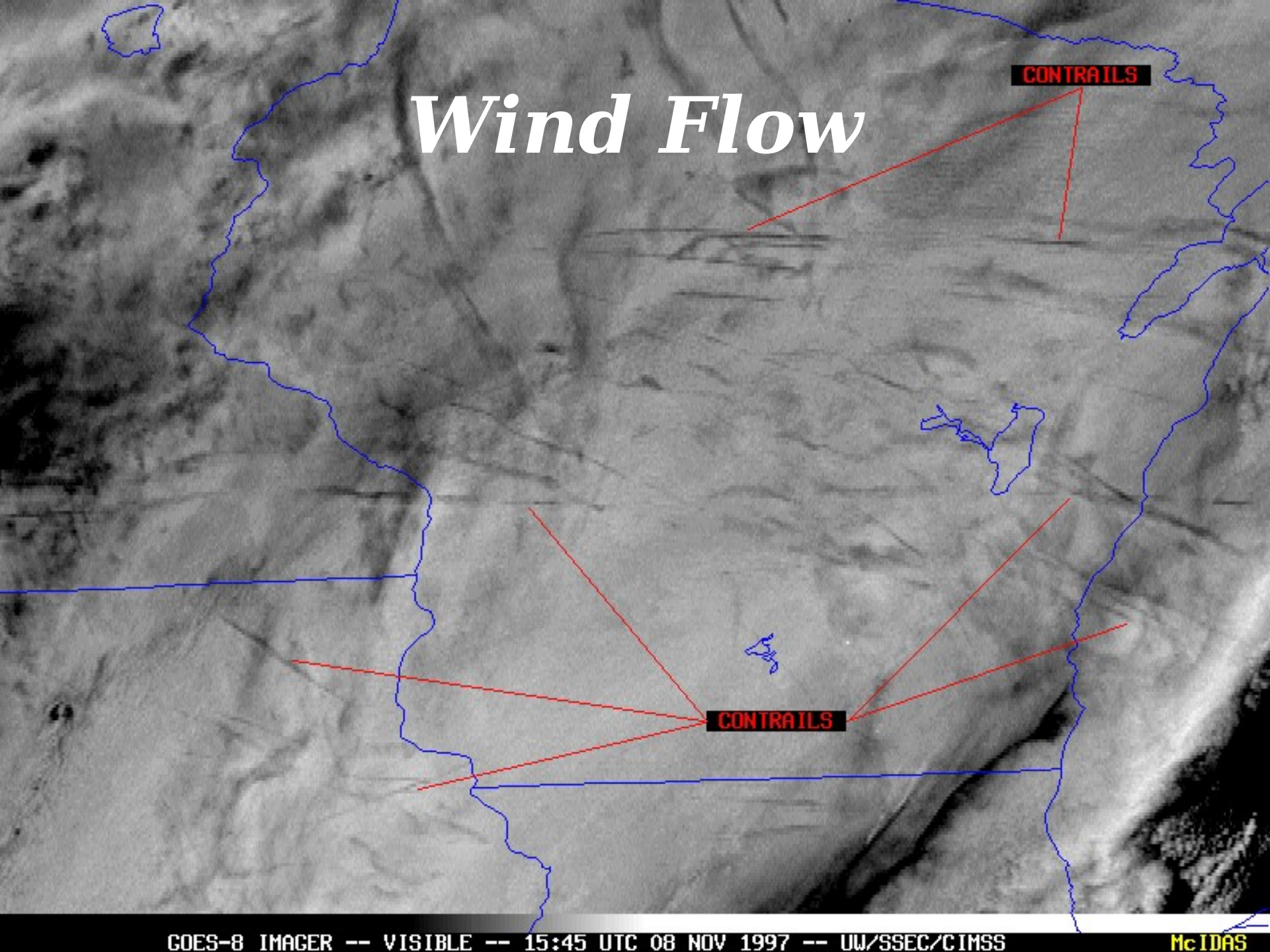
- Cumulus lines/streets occur when the low-level flow is nearly parallel to the cloud orientation.
- Ship trails indicate light anticyclonic flow, low marine inversion, and reduced visibility.
- Contrails are similar to ship trails, but colder on IR (higher).

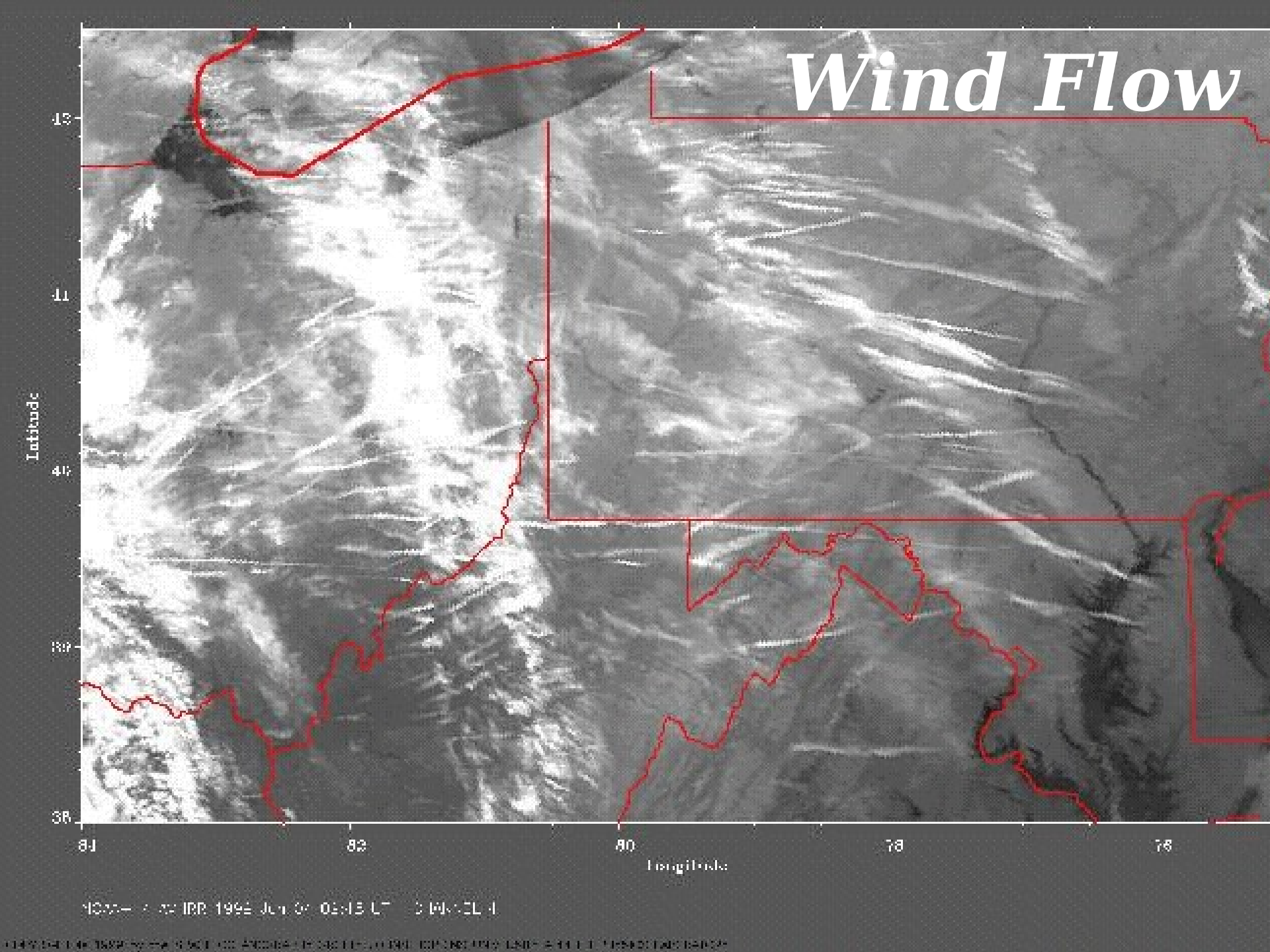

1831 14AP92 19A-2 01341 23341 CB2
Wind Flow


Wind Flow
2 G8VIS21.JPG 08/15/1997 19:15:15 CH1 (C) VAS-DAS,INC. Complete GOES GVAR Earth Station including dish, 12,495 804-525-5202


Wind Flow
30 GOES-9 IMAGER - VISIBLE - 20:15 UTC 15 JUL 1998 - CIMSS

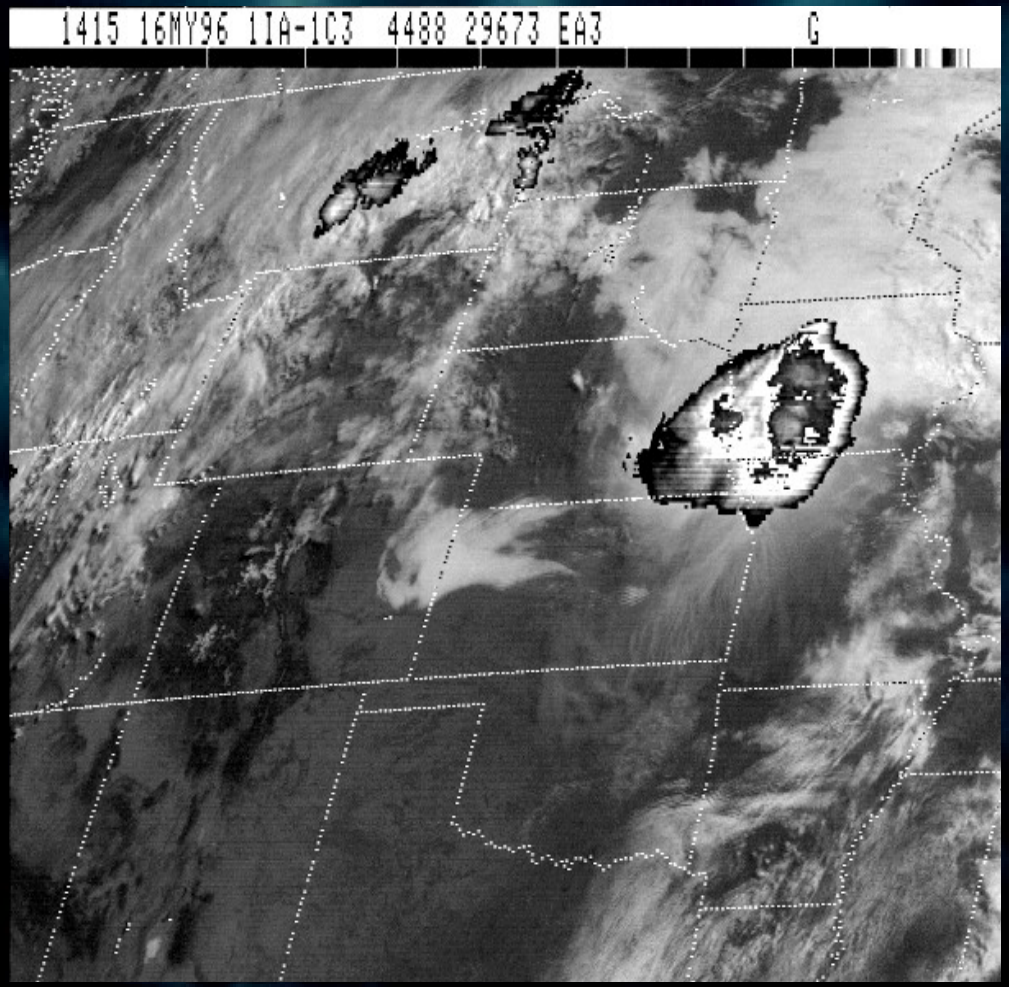

g10 DAYNIGHT LOWCLOUD 04/13/99 1630Z NRL Monterey 7541
Wind Flow
200
200
200

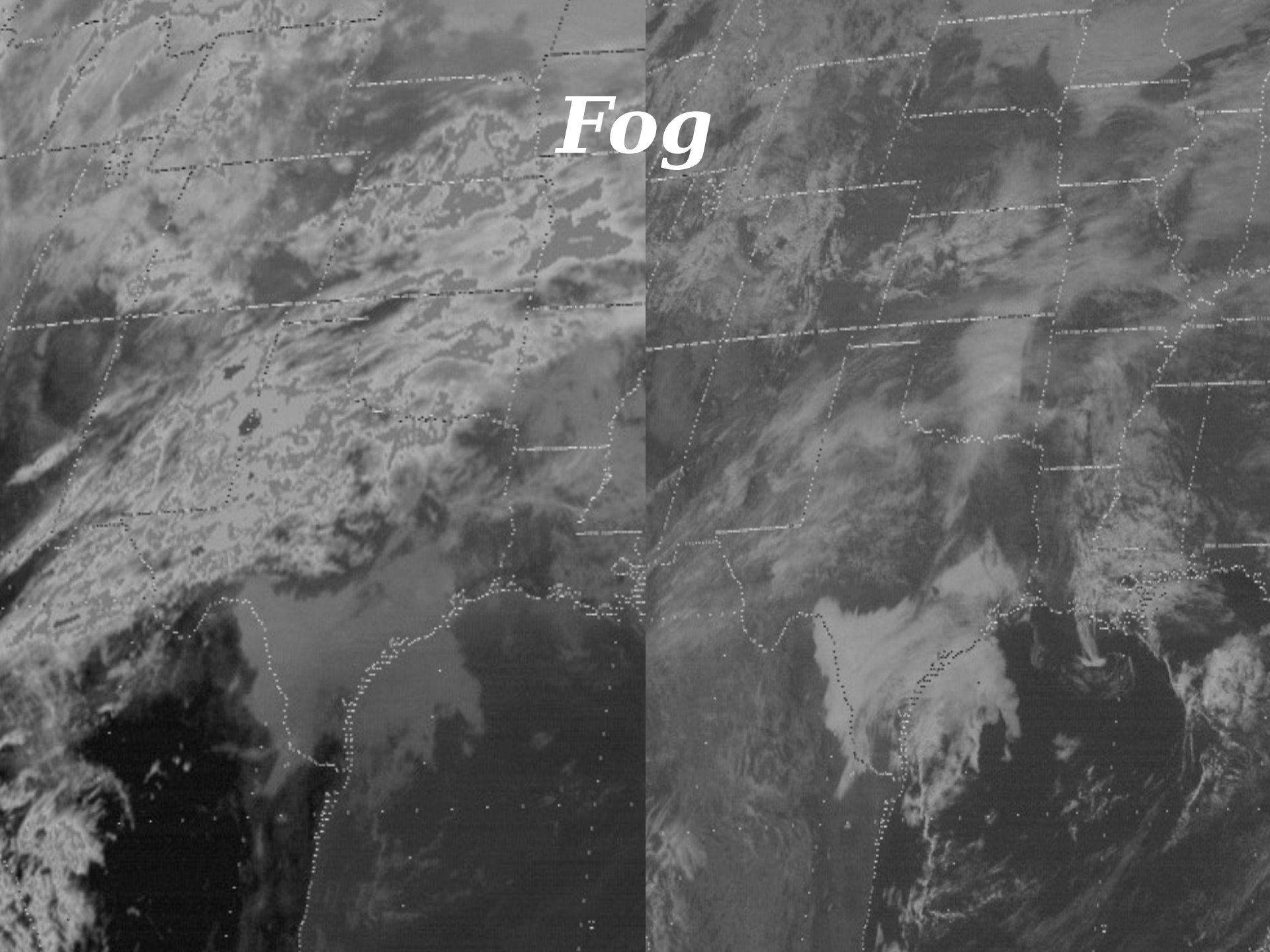

Wind Flow
CONTRAILS
CONTRAILS
GOES-8 IMAGER -- VISIBLE -- 15:45 UTC 08 NOV 1997 -- UW/SSEC/CIMSS
McIDAS


Wind Flow
Latitude
Longitude

Wind Flow

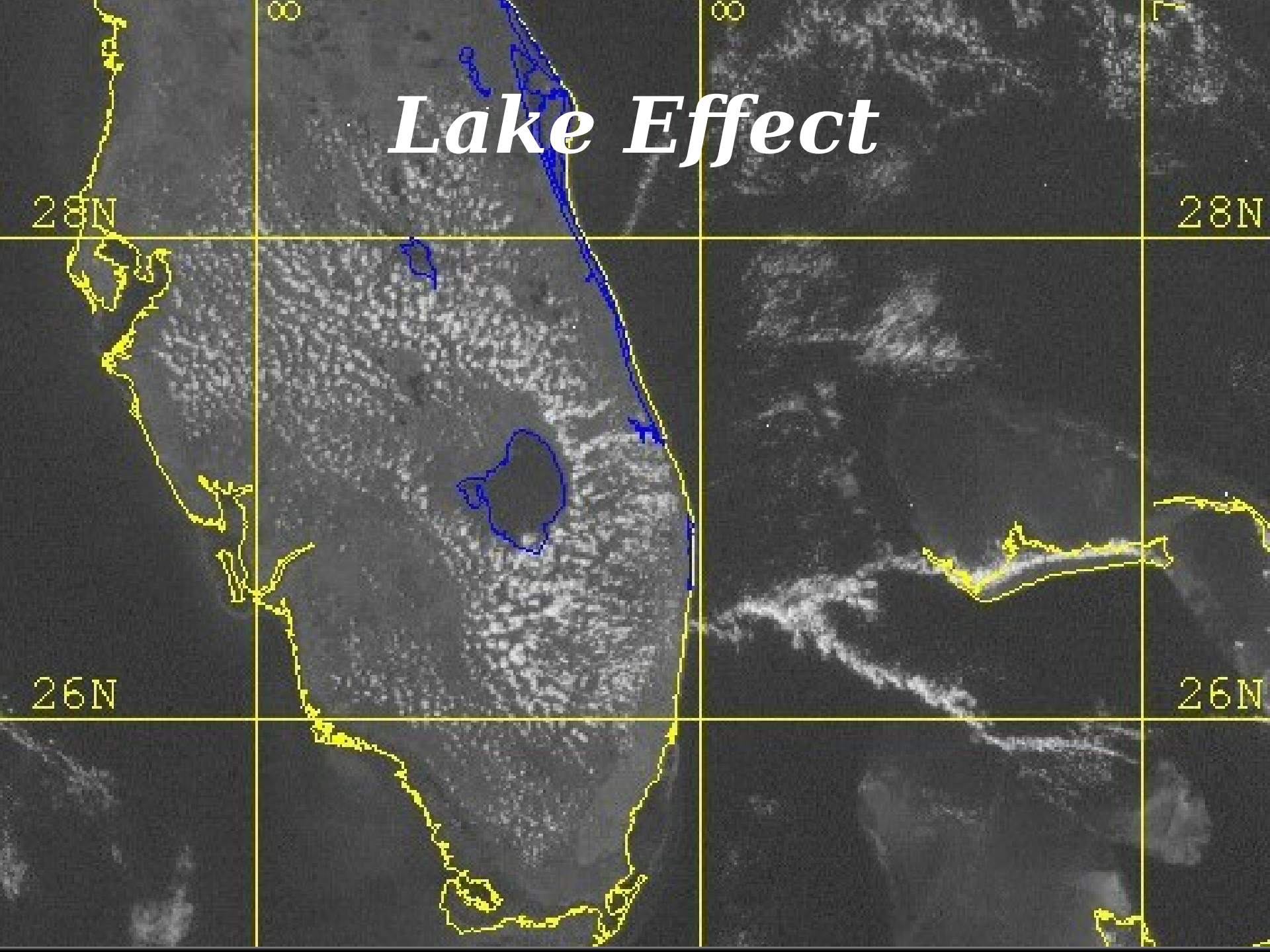
- Upslope/ orographic lift causes a sharp boundary along higher terrain/clou d boundary

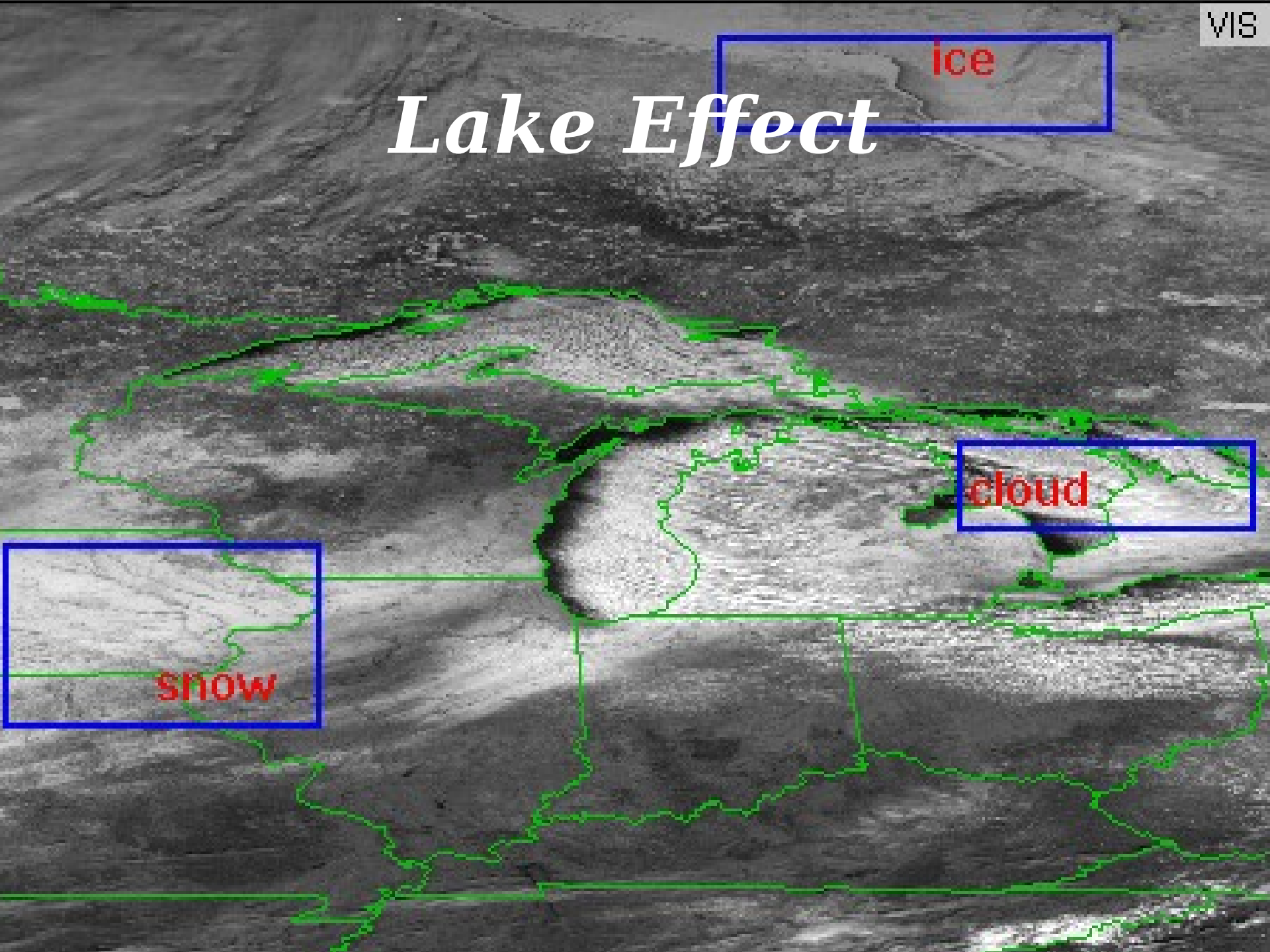


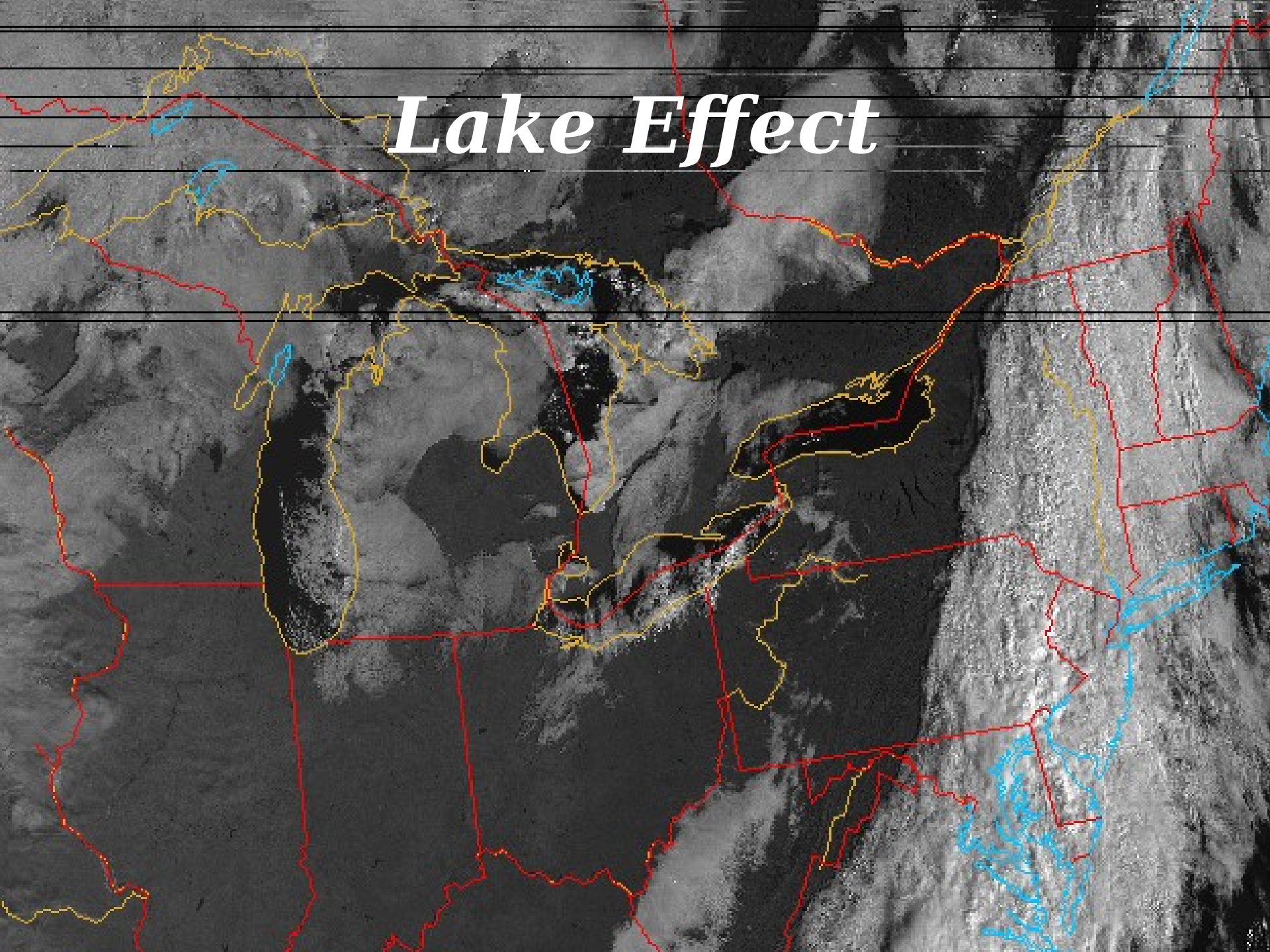

Fog

Wind Flow

- Lake effect
  - Clouds dissipate over cooler lake and downstream in summer
  - Cloud free upstream of lake; Formation takes place over warmer lake and extends downstream in winter


Lake Effect
28N
28N
26N
26N


VIS
ice
Lake Effect
cloud
snow


Lake Effect

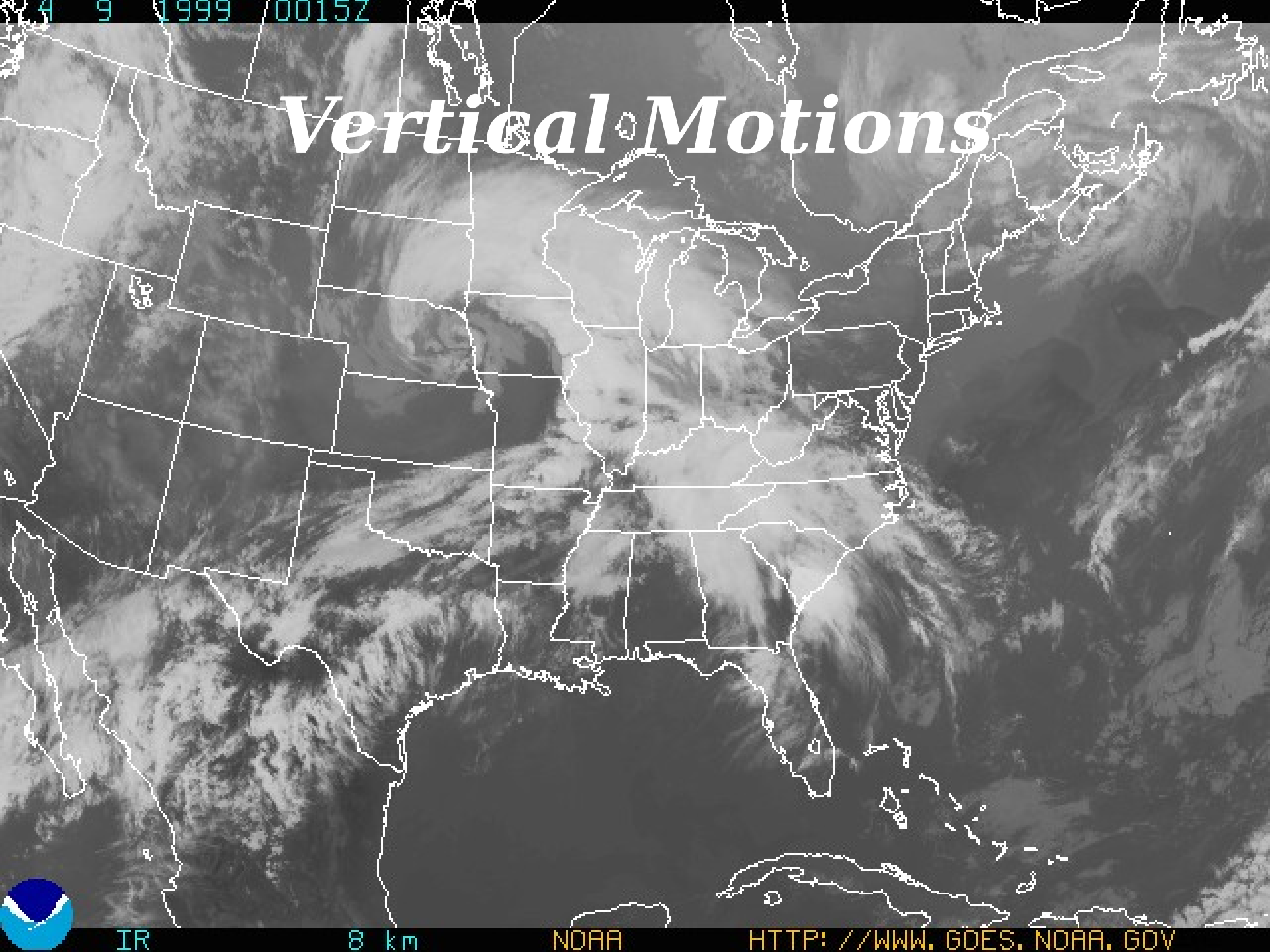
Wind Flow

- Low-level deformation zones
  - Most evident behind cold fronts
  - Axis of contraction is located between open-cell cumulus and closed-cell stratocumulus delineates the cold front/stationary front

Deformation Zones

Wind Flow

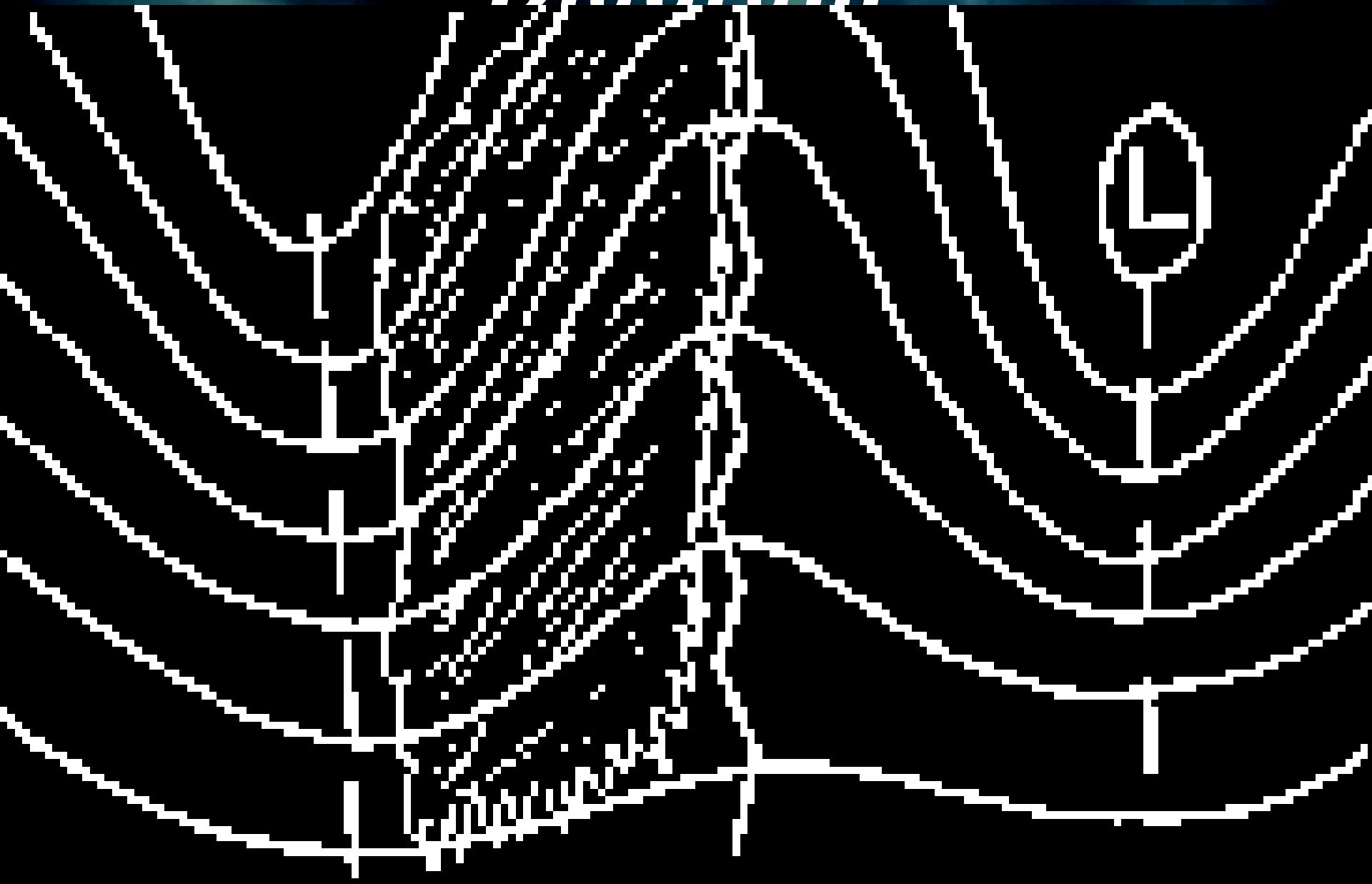
- Vertical motion
  - Divergence/convergence caused by speed maxima
    - Divergence in the left-front quadrant of a speed maximum is responsible for deformation zone cloudiness
    - Convergence in the right-front quadrant of the speed maximum is responsible for downward vertical motion and clearing in the dry slot


4 9 1999 /0015Z
Vertical Motions
IR
8 km
NOAA
HTTP://WWW.GOES.NOAA.GOV

Wind Flow

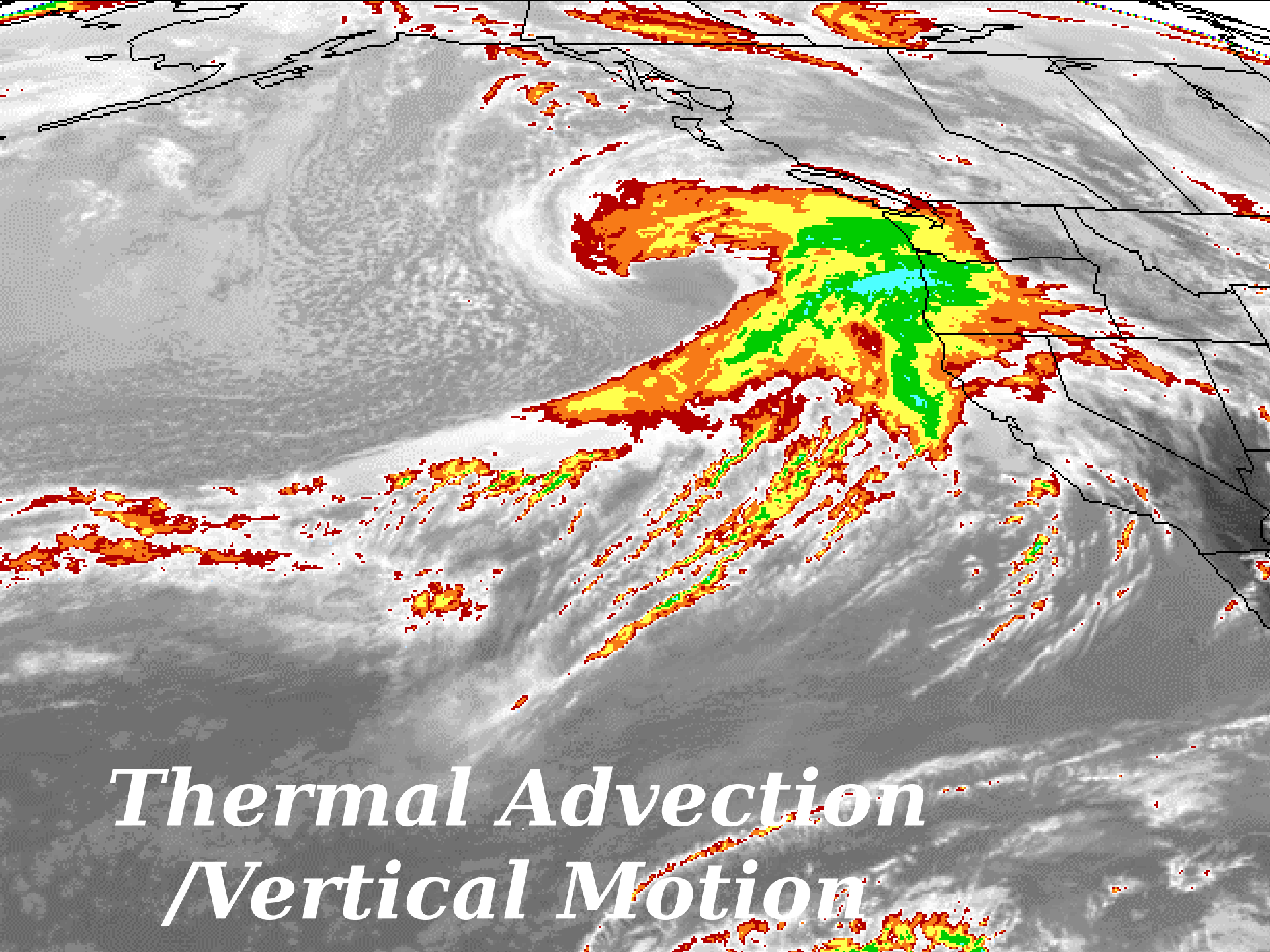
- Relationship of short-wave troughs a nd ridges to the synoptic-scale comm a cloud system
  - Troughs - upward vertical motion ahead of a major short-wave trough is responsible for large area of baroclinic zone cloudiness
  - Ridges - downward vertical motion ahead of a major short-wave ridge is responsible for dissipation of cloudiness downstream of the baroclinic system

Trough Ridge Couplet Diagram



Wind Flow

- Relationship of thermal advection to the synoptic-scale comma cloud system
  - Strong cold-air advection occurs west of the surface low, creating downward vertical motion behind cold front, enhancing the convergence behind the major short wave trough
  - Strong warm-air advection occurs east of the surface low, enhancing the upward vertical motion ahead of the major short wave trough


Thermal Advection
/Vertical Motion

Wind Flow

- Animated imagery
  - Interpretation techniques
    - Examine changes of cloud systems and flow over time
    - Observe entire area; Don’t lock onto one area

Wind Flow

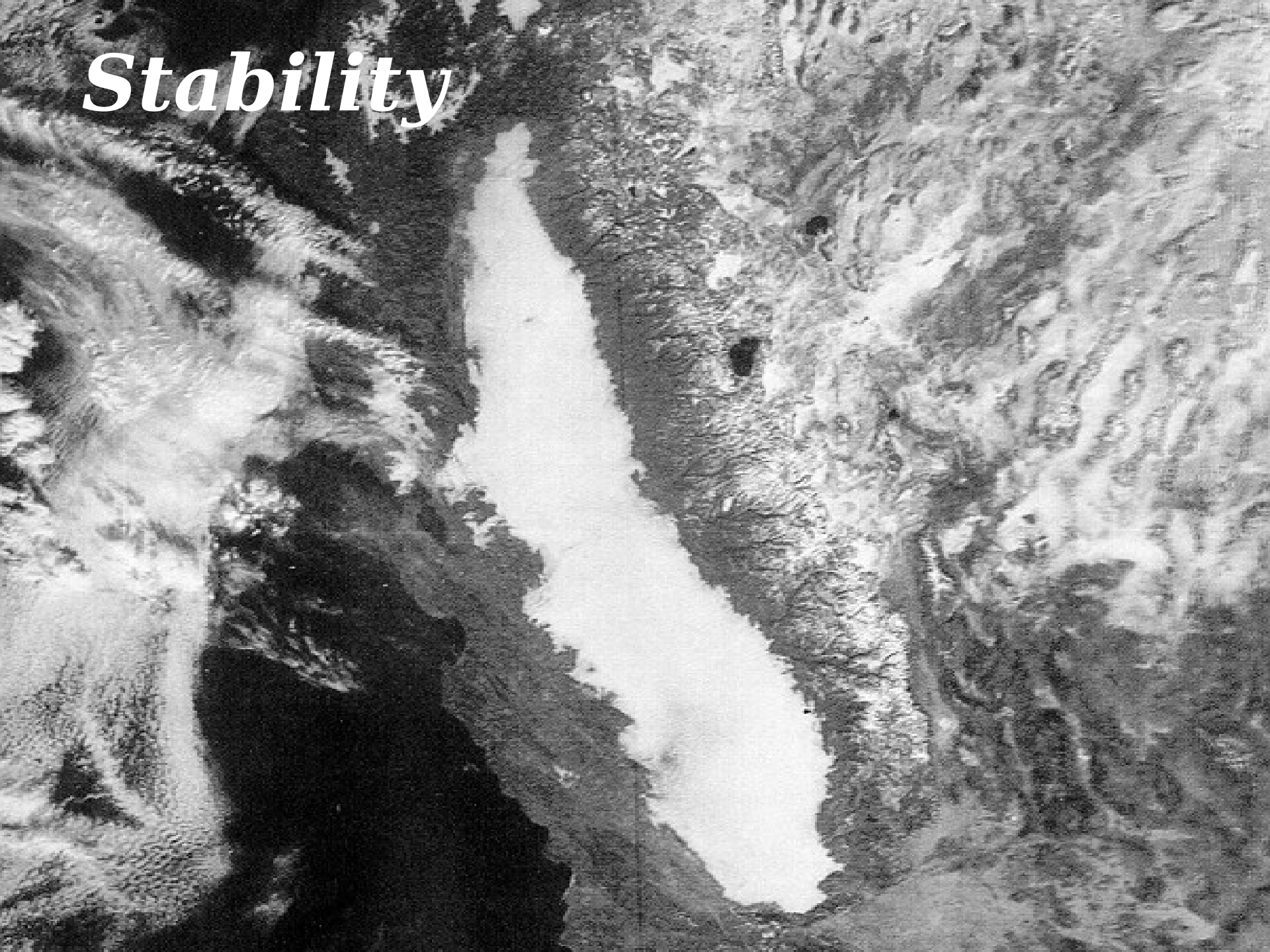
- Low-level wind flow
  - Low-level wind flow is determined by following the motion of low clouds with time; Their location in relation to systems; And their interaction with terrain
  - Infrared imagery - low clouds appear dark or murky
  - Visible imagery - use the skills learned with still imagery to determine flow

Wind Flow

- Upper-level wind flow
  - Upper-level wind flow is determined by following the motion of high clouds with time
  - On infrared imagery (unenhanced), high clouds appear brighter

Circulations

- Local modification to stability
  - Stabilization
    - Warm over cold, WOC condition
    - Results in stratiform cloudiness
  - Destabilization
    - Cold over warm, COW condition
    - Results in cumuliform cloudiness

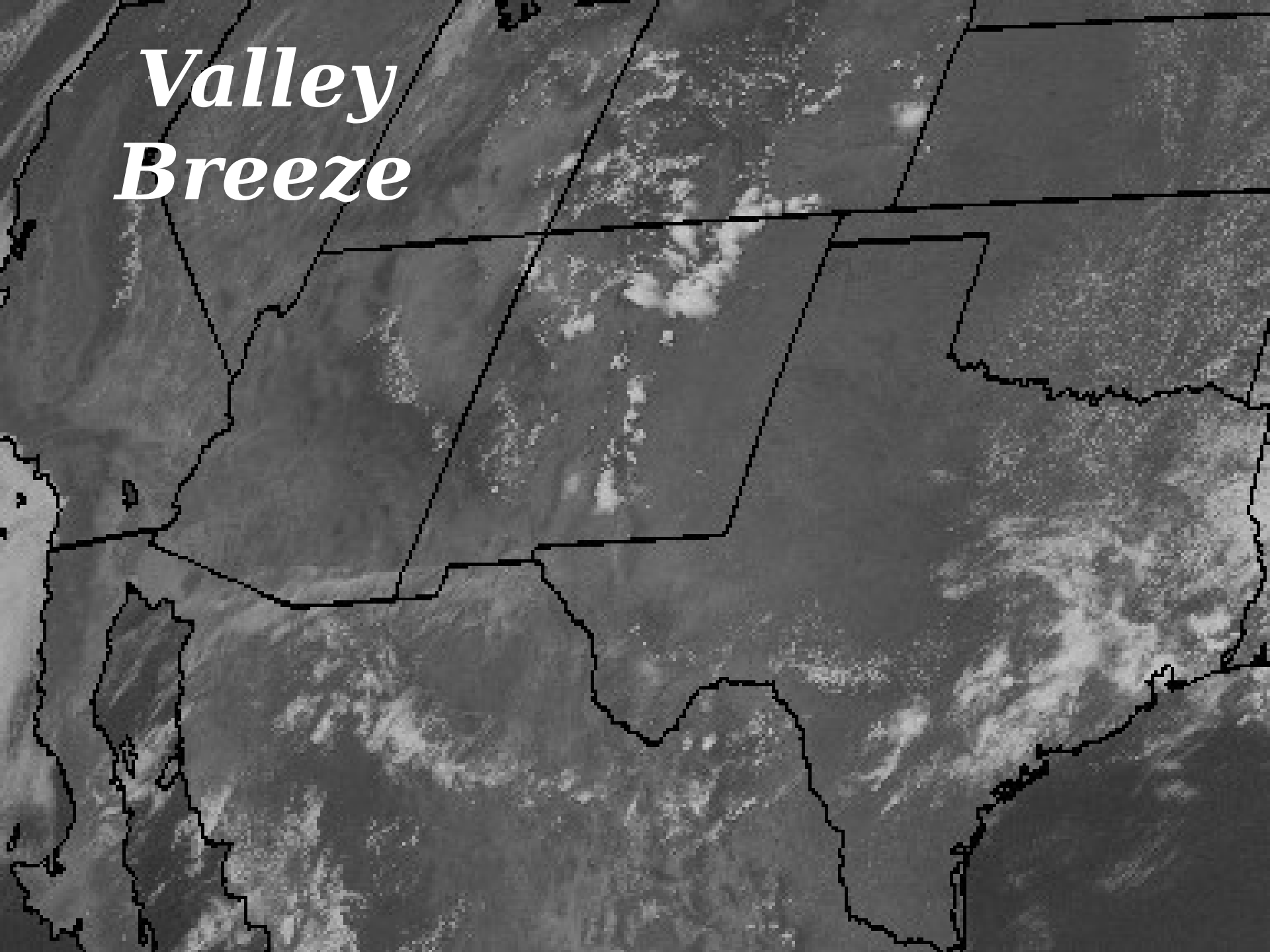

Stability

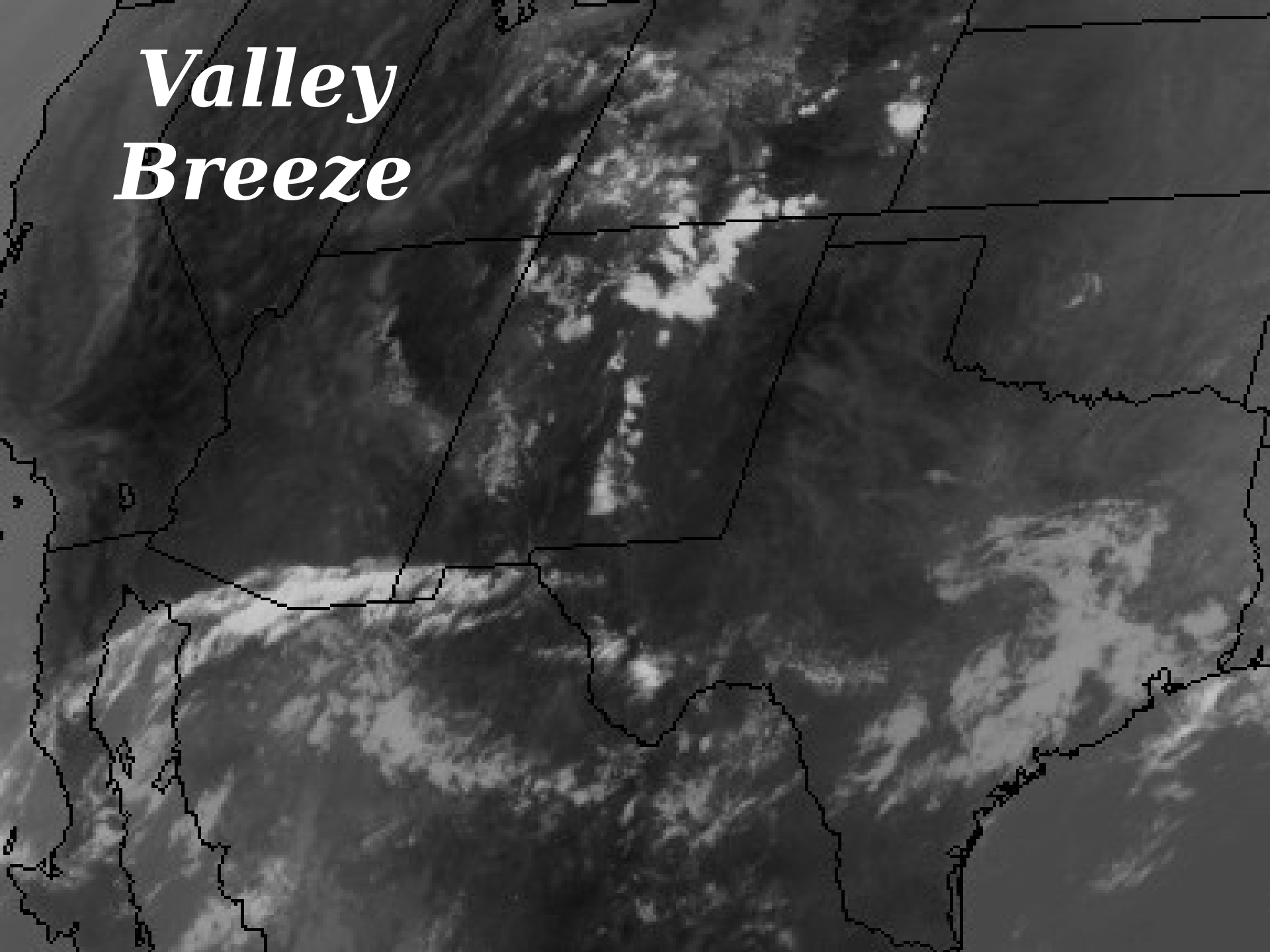
Circulations

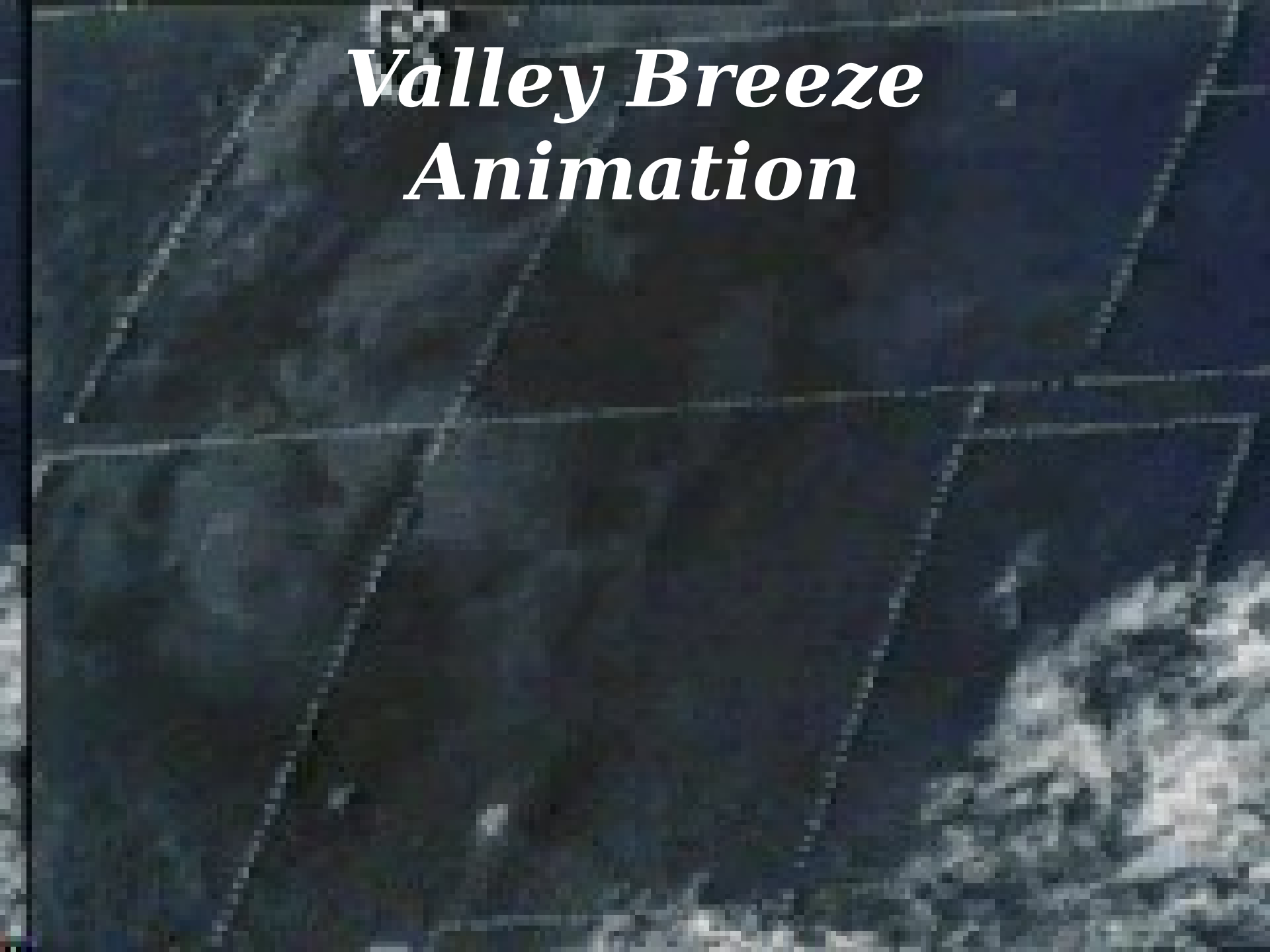
- Combination
  - Unstable in lower layers, stable aloft
  - Results in stratocumulus

Circulations

- Local circulations
  - Valley breeze
    - Cumulus or CB clouds form along ridgelines and peaks
    - Moisture availability and stability determine vertical extent
  - Mountain breeze
    - Radiational cooling in mountains at night; Dense air flows down to valleys which results in the formation of fog
    - Conforms to terrain


Valley
Breeze

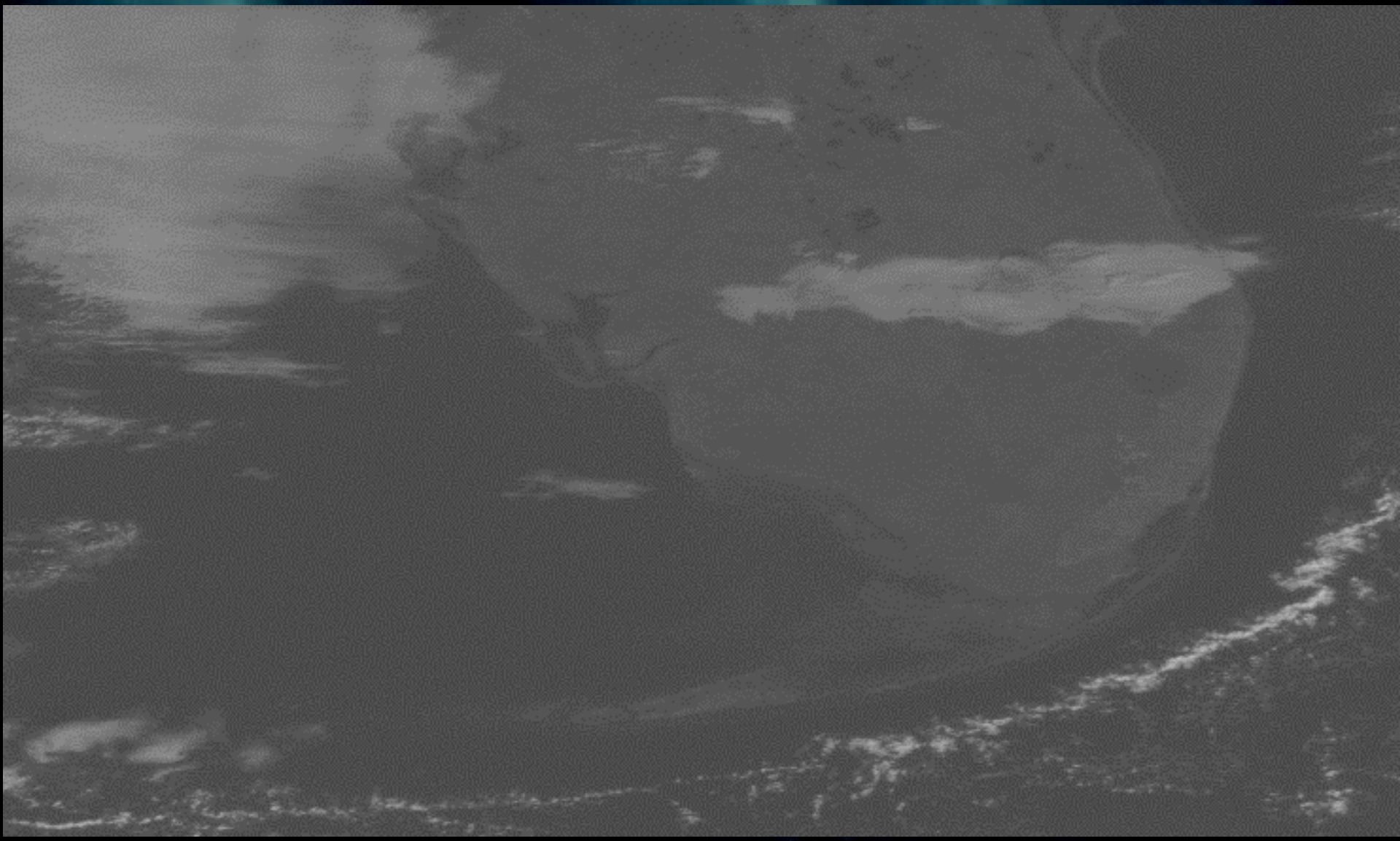

Valley
Breeze

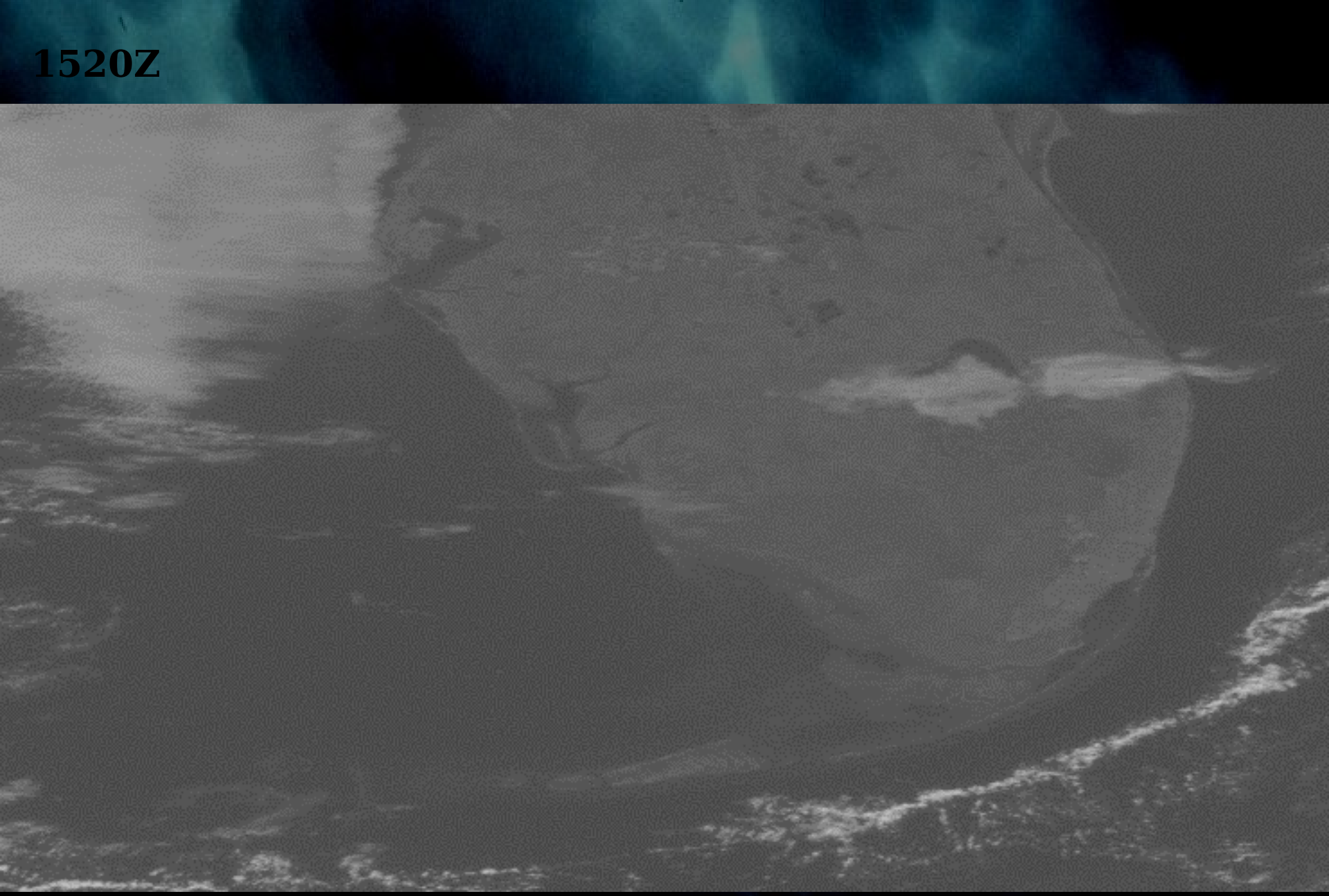

Valley Breeze
Animation

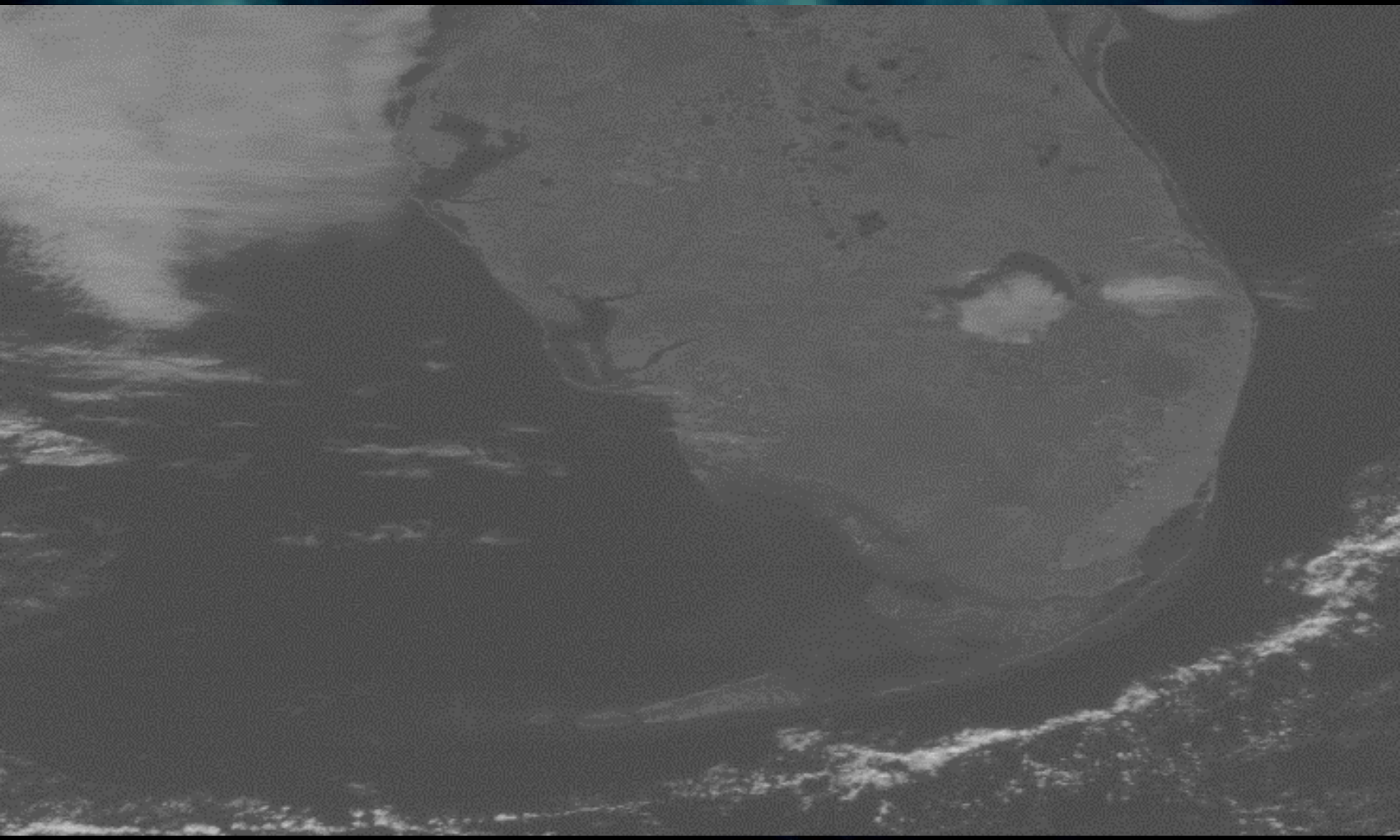
Circulations

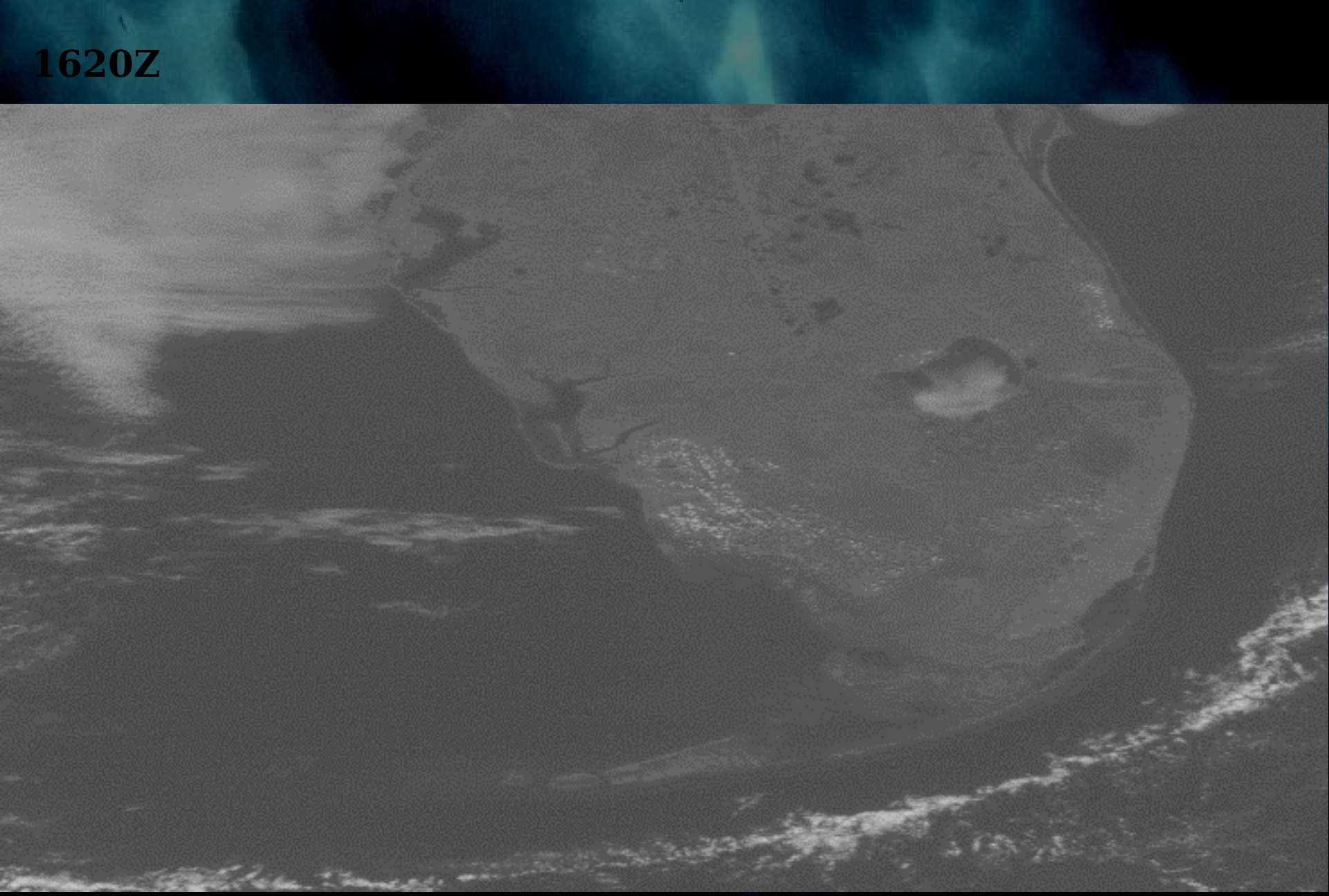
- Sea/lake breeze
  - Convective clouds, possible thunderstorms develop sea/lake breeze front
  - Area of no clouds occurs along and just offshore

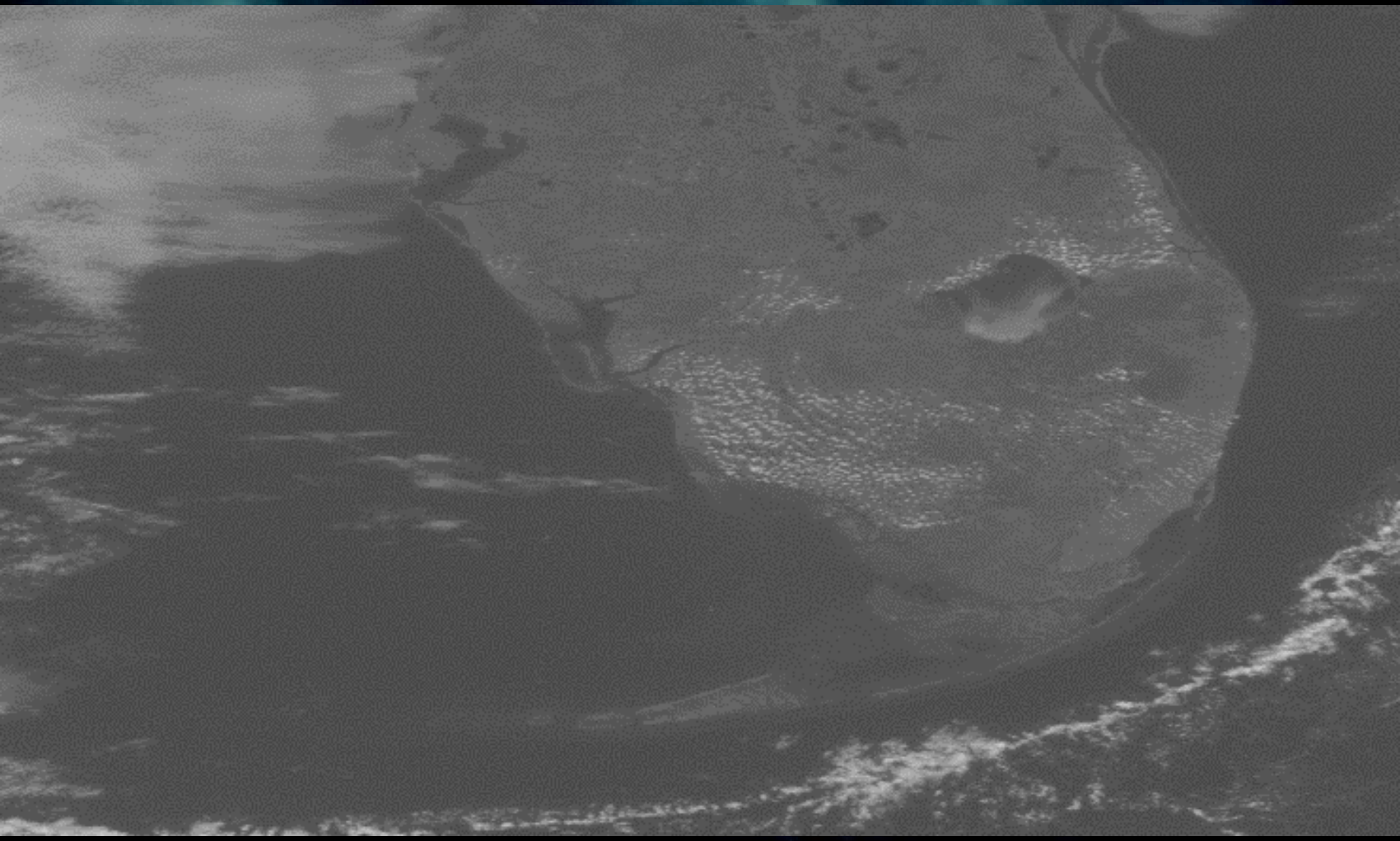
Lake Breeze Sequence

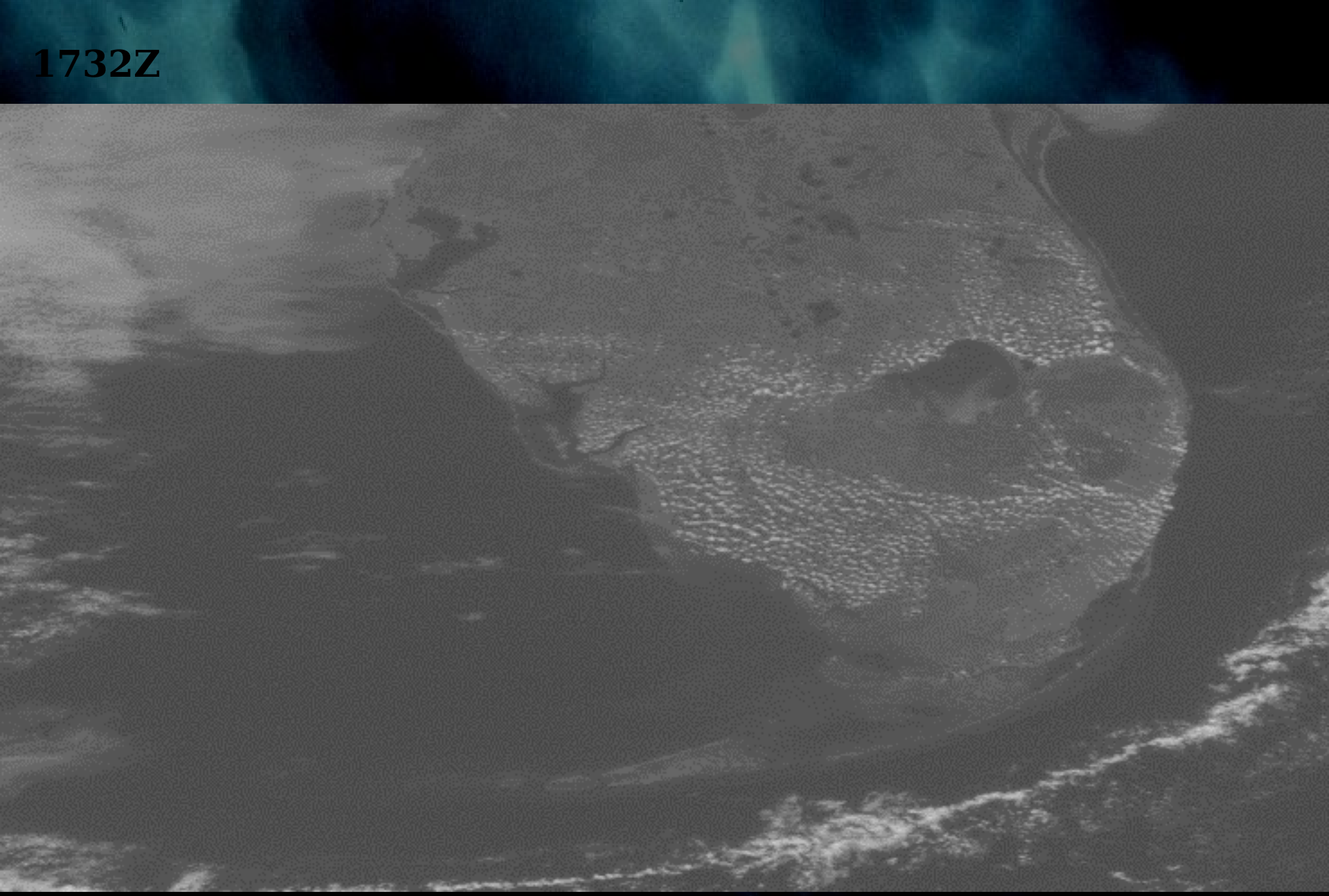


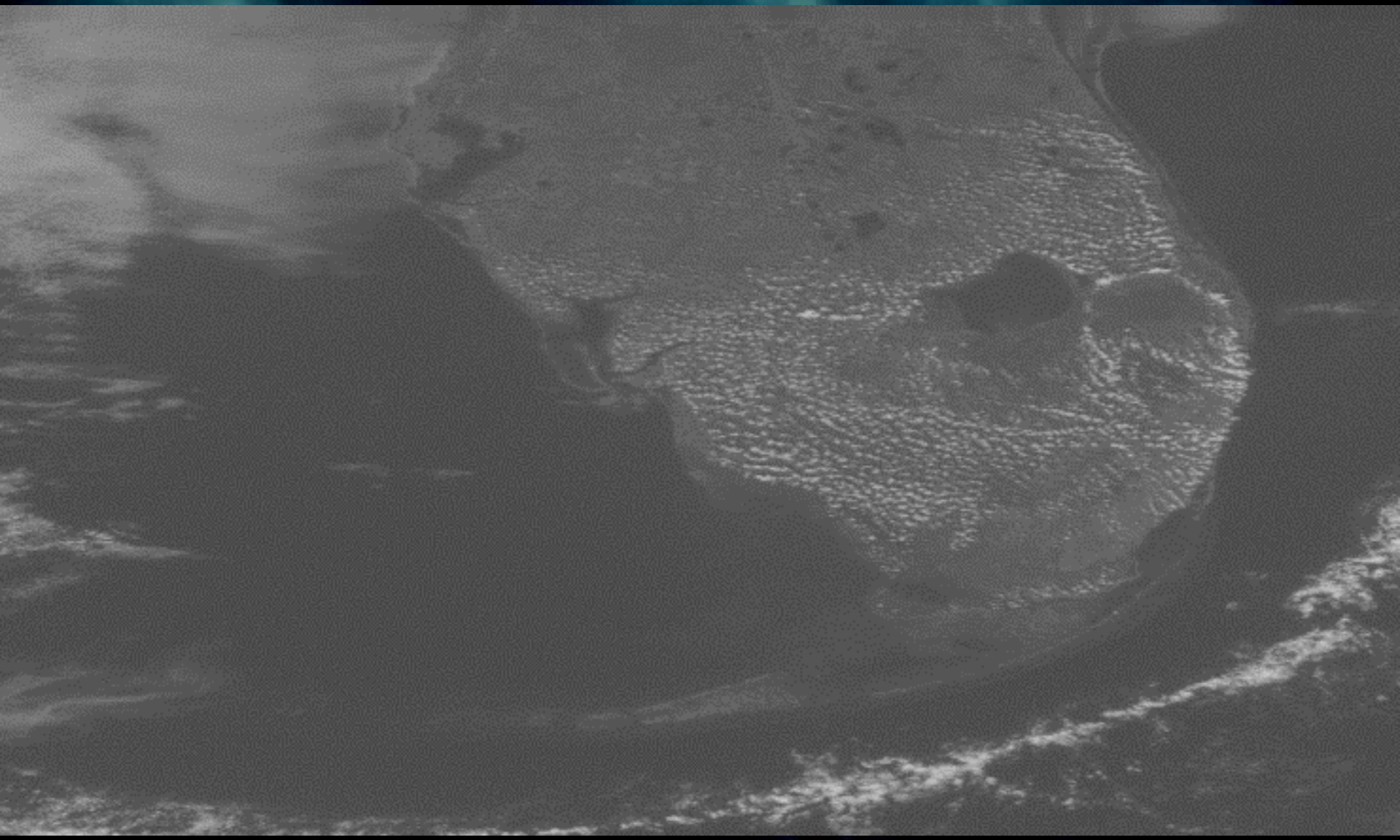

1520Z

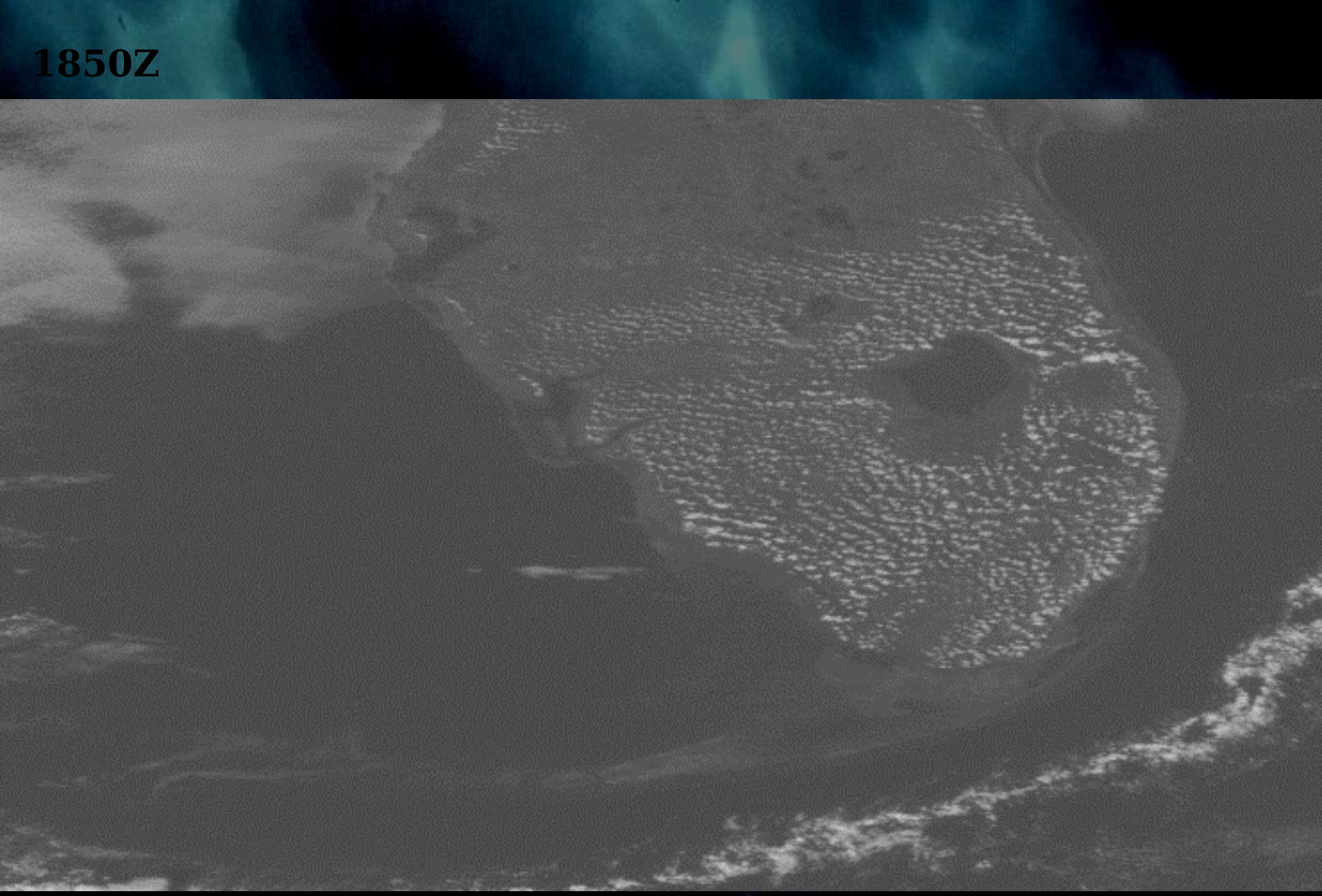



1620Z

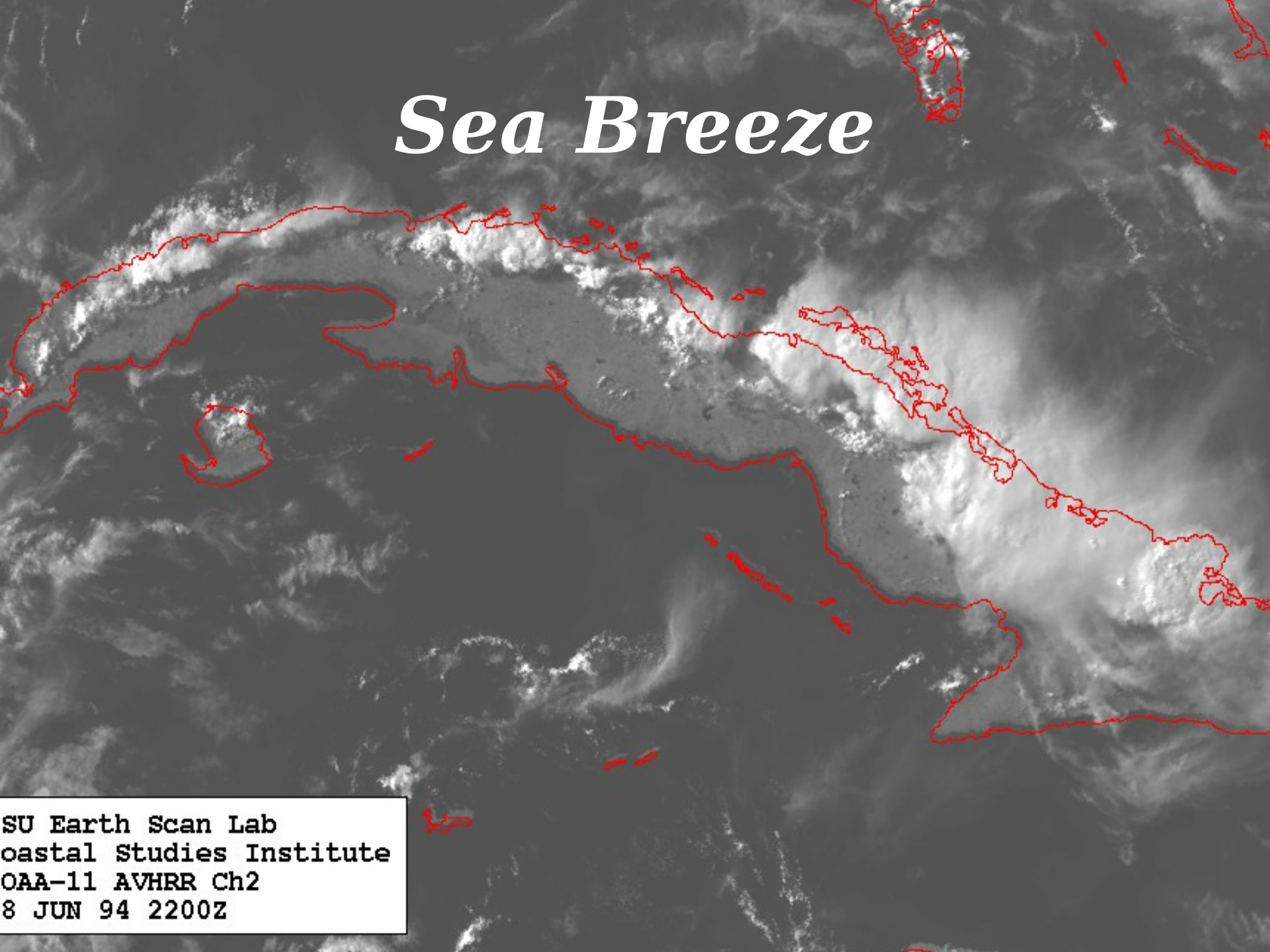



1732Z




1850Z

Sea Breeze


SU Earth Scan Lab
oastal Studies Institute
OAA-11 AVHRR Ch2
8 JUN 94 2200Z

Circulations

- Land breeze
  - Low-level convergence leads to cloudiness at the boundary between land breeze and the **environmental flow**
  - Favored location for cloudiness is over long narrow lakes; Also just offshore over open water

Land Breeze

Circulations

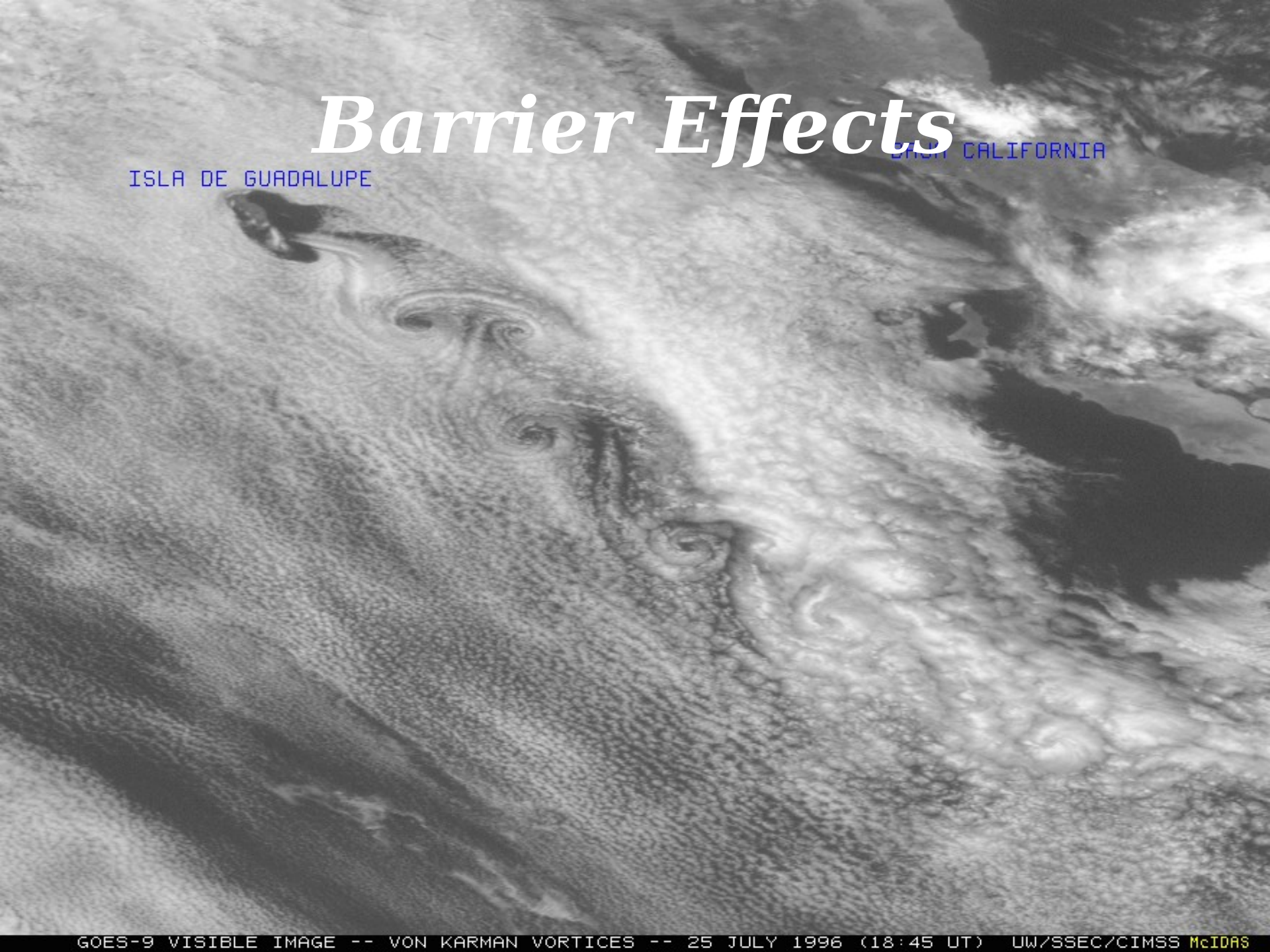
- Low-level jet
  - Develops in the warm sector
  - Moisture is sometimes visible as stratus

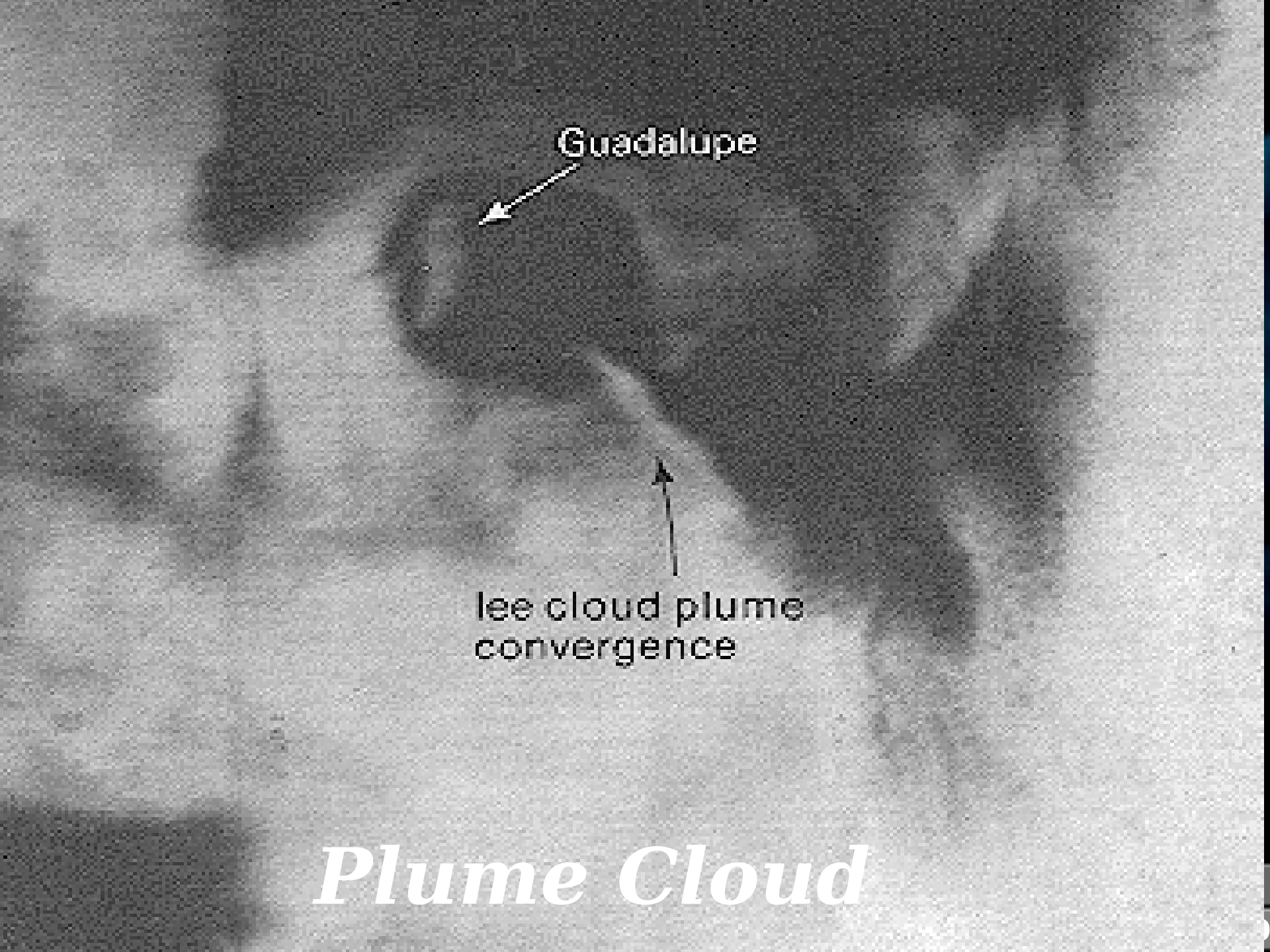
GOES-8 WV FOR 10 NOV 98 AT 20:45 UTC (SSEC:UW-MADISON)
NOAA
Low
Level
Jet

Circulations

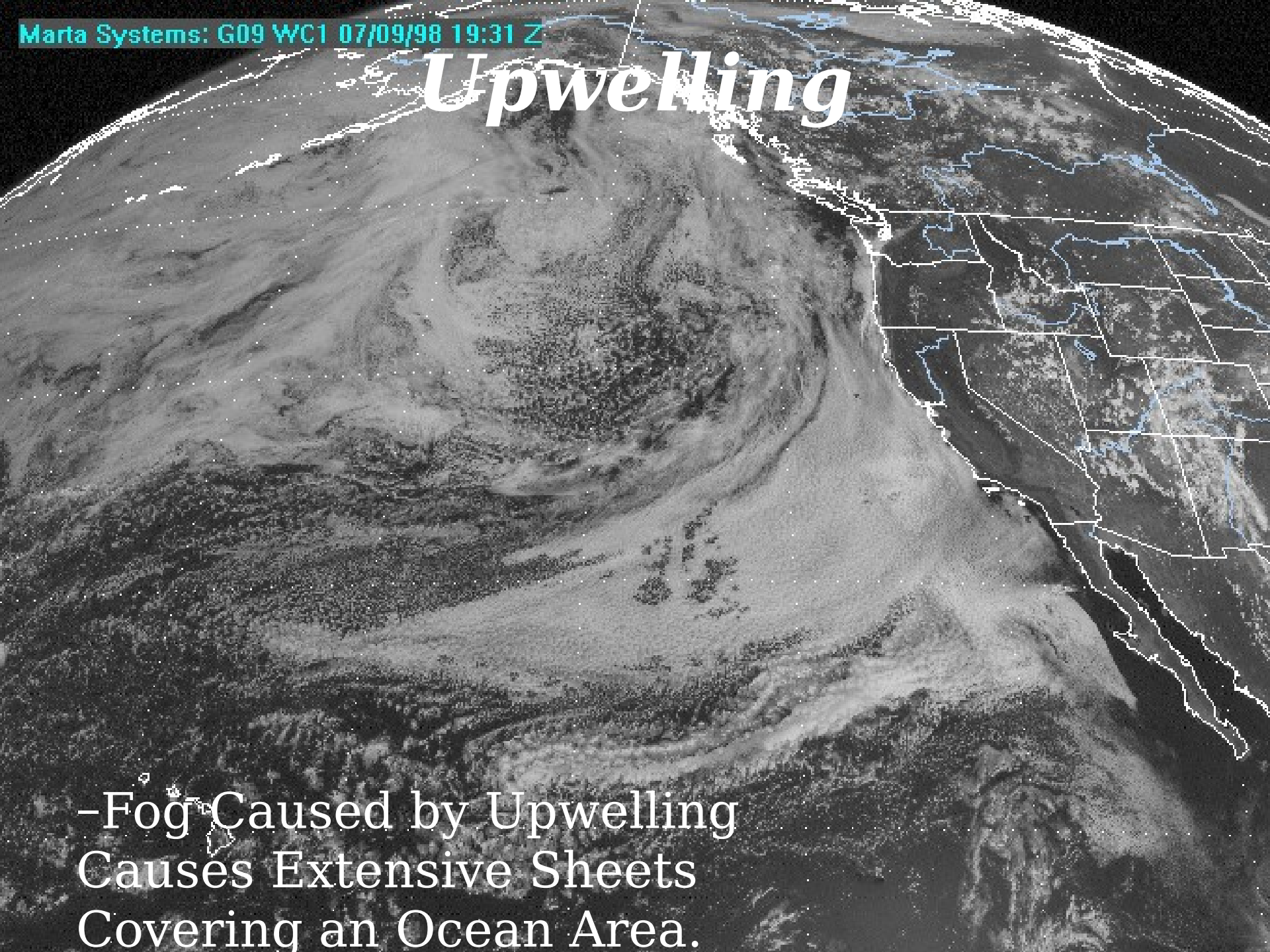
- Land/water interface
  - Barrier effects
    - Bow waves need an obstacle (island)
    - Karmen vortices occur when an inversion is present and terrain must penetrate the inversion
    - Cloud plumes are caused by air flowing around higher terrain

Barrier Effects





Plume Cloud



Upwelling

–Fog Caused by Upwelling Causes Extensive Sheets Covering an Ocean Area.

- APPLICATION: Assign Review Exercise 4.

- EVALUATION: Administer and evaluate Appraisal 302d. Give the Written Test at the end of the unit.